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US Army Corps of Engineers®
Engineer Research and Development Center

Building Information Modeling (BIM)

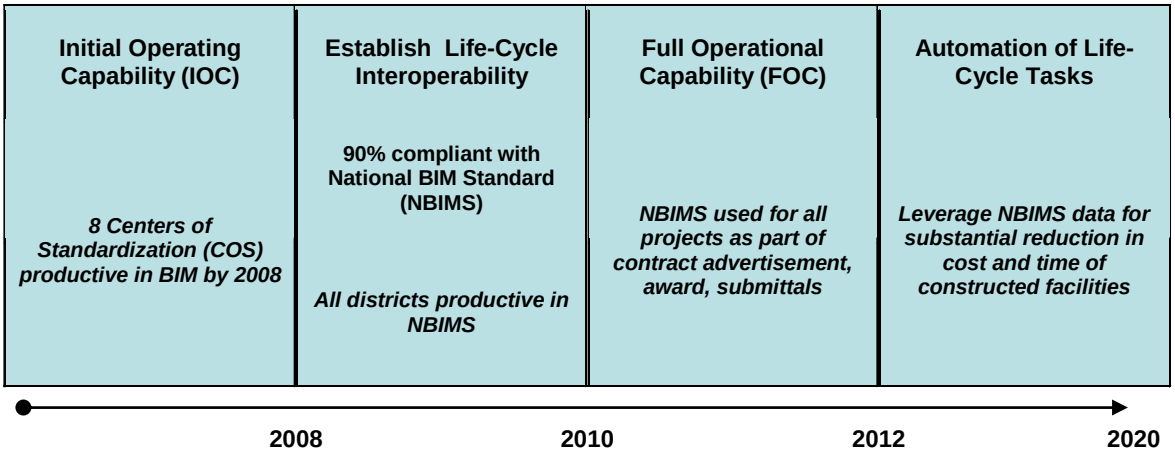
A Road Map for Implementation To Support MILCON Transformation and Civil Works Projects within the U.S. Army Corps of Engineers

Beth A. Brucker, Michael P. Case, E. William East, Brian K. Huston, Susan D. Nachtigall, Johnette C. Shockley, Steve C. Spangler, and James T. Wilson

October 2006

Building Information Modeling

Overview: U.S. Army Corps of Engineer Roadmap



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Final Report

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Abstract: Building Information Modeling (BIM) is a technology that is rapidly gaining acceptance throughout the planning, architecture, engineering, construction, operations, and maintenance industries. The challenge to the U.S. Army Corps of Engineers (USACE) is to proactively prepare for BIM, use it to drive down costs and delivery time, and maintain or even improve quality at the same time. This document outlines the strategic and implementation plans for using BIM technology to improve USACE planning, design, and construction processes. It describes how USACE will meet or exceed the vision of its customers, including the Office of the Secretary of Defense (OSD), the Army, and the Air Force. The scope of this plan is to focus on the implementation of BIM in the U.S. Army Corps of Engineer's civil works and military construction business processes, including the process for working with the USACE Architectural Engineering Construction (AEC) industry partners and software vendors.

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Preface

This study was conducted for Headquarters U.S. Army Corps of Engineers (HQUSACE) under the project: "A Road Map for Implementing Building Information Modeling (BIM) to solve the Time and Cost Challenges of MILCON Transformation." The HQUSACE POC was Mr. Robert Bank, CECW-CE.

The work was co-executed by the CADD/GIS Technology Center of the Information Technology Laboratory (ITL) and the Engineering Processes Branch, Facilities Division (CFN), of the Construction Engineering Research Laboratory (CERL). ERDC authors included: Mr. James T. Wilson, Ms. Beth Brucker, Mr. Stephen Spangler, Dr. Michael Case, Dr. William East, and Ms. Susan Nachtigall. Other special contributing authors were Mr. Brian Huston, BIM Manager, Louisville District; and Ms. Johnnie Shockley, Technology Transfer Coordinator, USACE Peter Kiewit Institute. Reviewers of this document include the Computer Aided Design and Drafting Communities of Practice (CADD CoP), the BIM Sub Community of Practice (BIM Sub-CoP), and the Field Advisory CADD (FAC) groups. The Director of ERDC-ITL is Dr. Jeffery P. Holland. The Director of ERDC-CERL is Dr. Ilker R. Adiguzel.

The CADD/GIS Technology Center, CERL and ITL are elements of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Commander and Executive Director of ERDC is COL Richard B. Jenkins, and the Director of ERDC is Dr. James R. Houston.

1 Introduction

1.1 Background

Building Information Modeling is an emerging technology with the potential to enable significant improvement in the speed, cost, and quality of facility planning, design, construction, operations, and maintenance.* According to the National Institute of Building Sciences:

> A Building Information Model (BIM) is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward.†

The potential of BIM stems both from its value as an open interchange mechanism between the tools used to perform the various functions of the AEC industry (standards) and the ability of computational tools to manipulate the model directly, with or without human intervention (computability). In a typical BIM-enabled process, the data model serves as the principal means for communication between activities conducted by professionals. When fully implemented, BIM will increase reuse of design work (decreasing re-design effort); improve the speed and accuracy of transmitted information used in e-commerce; avoid costs of inadequate interoperability; enable automation of design, cost estimating, submittal checking, and construction work; and support operation and maintenance activities.

This move to model-based standards and computability is not without precedent. Facing global competitive pressures on every front, automobile, airplane, electronics, and consumer goods manufacturers turned long ago to model-based digital design processes based on data that supported engineering analysis, bill-of-material generation, cost modeling, production planning, supply-chain integration, and eventually computer-driven fabri-

*Building Information Modeling may offer even more significant cost savings over operations and maintenance phases of the facility life cycle, but this document primarily focuses on those areas within the purview of the U.S. Army Corps of Engineers.

†D. K. Smith. (2006). Presentation. "Building Information Models: A Revolution in the Construction Industry." Accessible through URL: http://www.nibs.org/BIM/BIM_Revolution.pdf

cation on the factory floor.* International and domestic governmental agencies are beginning to require Industry Foundation Class (IFC) based submittals to acquire work. For example, Singapore is requiring IFC based submittals of government projects for code checking and permit approval. The General Services Administration (GSA) is requiring IFC-based submittals for spatial program validation for all projects, 2007 and beyond.

As a technology, BIM is rapidly gaining acceptance throughout the planning, architecture, engineering, construction, and operations and maintenance (O&M) industries. The challenge to the U.S. Army Corps of Engineers (USACE) is to proactively prepare for BIM, to use BIM to drive down costs and delivery time, and at the same time to maintain or even improve quality. BIM will be implemented for both Military and Civil Works processes. There are costs and risks involved, however. BIM technology will take time to mature and to be adopted by industry. This strategy seeks to clearly articulate a phased approach that enumerates our goals in adopting BIM, communicate our intentions to industry to encourage technology development, work with our customers to deliver their required products, and anticipate future technology that will advance productivity. The phased approach is designed to allow USACE to update and adjust the strategic plan every few years to match an evolving business and technological climate.

DoD strategies are also focusing attention on "shared knowledge" resources. The DoD Net-Centric Data Strategy (May 2003) outlines the vision for managing data in a net-centric environment. Net-centricity compels a shift to a "many-to-many" exchange of data, enabling many users and applications to leverage the same data-extending beyond the previous focus on standardized, predefined, point-to-point interfaces. Hence, the net-centric data objectives are to ensure that all data are visible, available, and usable—when and where needed—to accelerate decision cycles. This strategy includes installation assets, which could be represented by BIMs. DoD Directive No. 8100, dated 19 September 2002 † states that the Global Information Grid (GIG) shall support all DoD missions with information

* P. G. Bernstein and J. H. Pitmann. Website. "Barriers to the Adoption of Building Information Modeling in the Building Industry. Accessible through URL: http://images.autodesk.com/adsk/files/BIM_Barriers_WP_Mar05.pdf

† Department of Defense (DOD). (19 September 2002). DoD Directive 8100.1. *Global Information Grid (GIG) Overarching Policy*. Accessible through URL: http://www.dtic.mil/whs/directives/corres/pdf2/d81001p.pdf

technology, for national security systems, joint operations, joint task force (JTF), and/or combined-task force commands, that offers the most effective, efficient, and assured information handling capabilities available, consistent with national military strategy, operational requirements, and best-value enterprise-level business practices.

BIM is related to enterprise geospatial initiatives by the need to geolocate facilities, but distinct in the type and detail of modeling required. The U.S. Department of Defense (DoD) is developing a new and distinctly different approach to how it creates and manages its geospatial information resources to manage defense facilities. This approach is named the Defense Installation Spatial Data Infrastructure (DISDI). The creators of DISDI envision an institutionalized process where installation geospatial data (in GIS, CAD, and imagery formats) are assembled, disseminated, and maintained in a fashion that supports validated DoD installation management and strategic basing decision missions worldwide. DISDI focuses on the business processes, people, and policies necessary to provide installation visualization and mapping capabilities, not on Information Technology (IT) acquisition and IT development. DISDI is not a system but rather a mechanism by which geospatial data stewarded at and by DoD installations can be shared with validated stakeholders to meet their critical installation visualization requirements. The USACE BIM strategy will require a strategy for connection to geospatial data in general and DISDI in particular (http://www.acq.osd.mil/ie/bei/disdi.htm).

The BIM strategy will also be required to consider the General Fund Enterprise Business System (GFEBS), a web-based system that will allow the U.S. Army to share financial and accounting data across the Service.* The GFEBS implementation involves standardizing all financial management and accounting functions, resulting in a system for Army financial professionals to access timely, reliable, and accurate information. GFEBS includes real property accounting functionality, including information typically found in a BIM. All of these tools will improve cost management and control, allow more time to perform financial analysis, and facilitate a more accurate understanding of the value and location of property.

*U.S. Army. Website. *General Fund Enterprise Business System (GFEBS). Accessible through URL:* http://www.gfebs.army.mil/

Each strategic goal listed in this document is accompanied by a theme, metrics, target date, and objectives (as appropriate). Objectives may also have a metric and description. This work summarizes the BIM implementation plan that describes how its goals and objectives will be achieved.

1.2 Objective

The objective of this work was to outline the strategic and implementation plans for using BIM technology to improve the planning, design, and construction processes of the U.S. Army Corps of Engineers. This document describes how USACE will smoothly meet the vision of our Department of the Army (DA) proponents, including the Office of the Secretary of Defense (OSD), the Army, and the Air Force.

1.3 Approach

The following Vision and Road Map is a culmination of the lessons learned on BIM from participating COE districts, A-E industry, and facilities research and modeling standards organizations. The key to success in the implementation of BIM is not to simply automate existing processes, but rather to create a new leaner business process enabled by BIM technology. The appendices to this report contain more detailed information for BIM support and implementation:

- Appendix A: Strategic Plan-Goals and Objectives (p 15)
- Appendix B: BIM Implementation Plan for the U.S. Army Corps of Engineers (p 22)
- Appendix C: Dataset Evolution Instructions (p 45)
- Appendix D: BIM Design Team Work Instructions (p 51)
- Appendix E: A-E Contract Language (p 64)
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- Appendix G: Example – Army Position Description for BIM Manager (p 66)
- Appendix H: Memorandum: Realignment/Establishment of Centers of Standardization (COS), FY06 (p 71)
- Appendix I: BIM Related Roles and Responsibilities (p 72)

1.4 Scope

The scope of this strategic plan is to focus on the implementation of BIM in the U.S. Army Corps of Engineer's civil works and military construction business processes. This will include the process for working with the USACE Architectural Engineering Construction (AEC) industry partners and software vendors.

1.5 Mode of Technology Transfer

This report will be made accessible through the World Wide Web (WWW) at URLs:

- The CADD & BIM USACE Communities of Practice (CoP) Portal on the Technical Excellence Network (TEN):
  https://ten.usace.army.mil/TechExNet.aspx?p=s&a=COPS;14
- Engineer Research and Development Center sites:
  https://tsc.wes.army.mil/
  http://www.cecer.army.mil

2 BIM Status, Requirements, and Goals

2.1 Vision

USACE will be a leader in using Building Information Modeling to improve delivery and management of facilities for the nation.

2.2 Status of BIM in the Corps

The Corps of Engineers has already begun to prepare for BIM in a number of ways. First, a Project Delivery Team (PDT) was formed in March 2005 to investigate the potential of BIM and make recommendations for an adoption strategy. This road map is a product of that PDT. As part of MILCON transformation, the Design-Build model request for proposal template includes language to encourage contractors to use BIM as part of their responses. This important step is a practical way to alert the industry that USACE supports the use of BIM and is moving in that direction, without being prescriptive or placing an undue burden on contractors.

USACE has also provided guidance to the Centers of Standardization (COS) that they will be required to use BIM on their standard designs. As stated in the "Realignment/Establishment of Centers of Standardization (COS)" memorandum, dated 3 March 2006 (see Appendix H), the COS will be responsible for developing and/or maintaining BIM models for standard facility types.

Several USACE district offices have conducted projects with vendor specific BIM modeling platforms. Two districts especially significant to the initial BIM PDT efforts were the Louisville District and Seattle District. The Seattle District's first project was a Barracks Complex at Fort Lewis, WA. In November 2004, the Louisville District, with guidance and funding from the Army Reserve, targeted a project, an Army Reserve Training Center in Raleigh Durham, NC, for implementation in BIM. This in turn influenced the Architect-Engineer firms (A-Es) working on Army Reserve projects to begin working in BIM. The Army Reserve has long been an early adopter of new technologies and processes and strongly encouraged Louisville District's leadership and HQUSACE to adopt BIM. As a result of several districts and A-Es collaborating and sharing lessons learned on

implementing BIM, a Corps BIM Sub Community of Practice was created in December 2005. In May 2006, the Louisville District BIM Team held a BIM information session for all Corps of Engineer Districts.

USACE also has representation on the National Institute of Building Sciences' (NIBS') Facility Information Council, which is creating the National BIM Standard (NBIMS). USACE ERDC employees have been transferring technology from the facilities acquisition research and development program to support the development of the modeling International Alliance for Interoperability (IAI) Industry Foundation Class (IFC) standard.* Finally, the Fort Future program has developed Facility Composer, an application designed to quickly create an initial BIM model, or early design view, from libraries of standard facilities. Facility Composer ensures that Army requirements are embedded in the BIM model from the beginning. Equally important, it ensures that new requirements and lessons-learned can be populated quickly and accurately.

2.3 USACE Technology Requirements

USACE will maximize use of available products and training. Districts may use existing purchasing agreements (Enterprise License Agreements [ELA]) to minimize the cost of implementing BIM. The ELA with Bentley Systems Inc., which includes support for training, BIM capable modeling software, analysis software, visualization, quality assurance, drafting, and documents management solutions, is available to all Corps entities through 2007. ProjectWise™ is the designated collaboration tool for USACE. No other collaboration tools are approved for military or civil works projects.

The intent of limiting the number of tools is to provide rapid implementation through platform-specific implementation requirements followed by broader vendor-neutral goals. As interoperability improves between platforms, the strategic plan and implementation plan will be modified to support multiple NBIMS-compliant platforms.

* Dr. Francois Grobler (ERDC) serves as the IAI North American Technical Coordinator, while Ms. Susan Nachtigall (ERDC) leads the North American Implementer Support Group, currently developing standards for early design and planning information. Dr. William East (ERDC) serves at the Chair of the NBIMS Development Team and leads the Construction Operations Building Information Exchange (COBIE) project.

To achieve initial operating capability (IOC) between districts, there is a need for interoperability within the districts. To ensure virtual teaming and data sharing, the Corps of Engineers will focus on specific vendor applications until reliable interoperability using NBIMS is achieved.

2.4 Customer Technology Requirements

As in the past, when a District has a customer that has a requirement for BIM models that work in non-ELA software, the district should plan to conduct training in that non-ELA software's BIM technology. If that District is a COS, it will need to schedule training in all necessary BIM packages. For example, if the District foresees some customers requesting Autodesk BIM models of their COS facility type, they should prepare to maintain both Bentley and Autodesk BIMs until reliable interoperability between the BIM packages is achieved.

If the customer is only interested in receiving construction document files (i.e., model files and sheet files) in *.dwg* rather than *.dgn* format, the District can still develop the BIM model using ELA BIM products. After the extractions are produced from the BIM model, from that point forward all model files and sheet files can be developed and delivered in .dwg format.

If the customer does not specify what software the BIM model is to be delivered in (e.g., "provide a BIM model"), the District will develop the BIM model using software obtained through the Bentley ELA. However, it is recommended that discussions be held with the customer to determine their product expectations before work proceeds.

Conversely, if the customer is a Corps District or COS, all BIM models are to be delivered by the A-E/Contractor in Bentley TriForma format.

2.5 Long-Term Strategic Goals

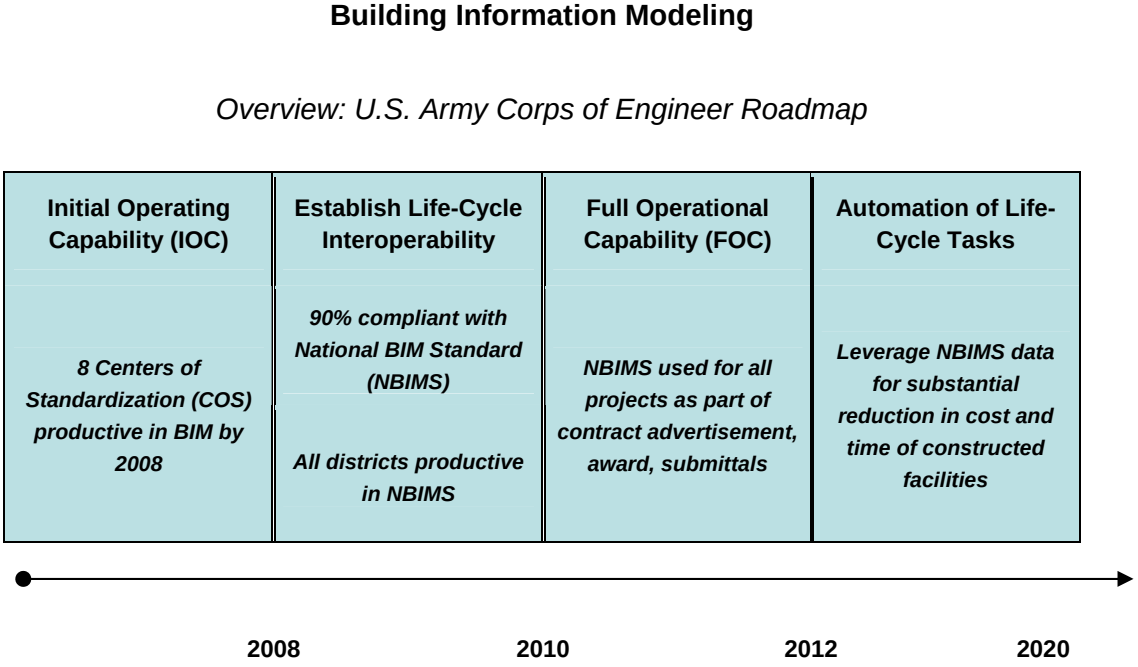

Figure 1. Long-term strategic goals for BIM, NBIMS and interoperability in the U.S. Army Corps of Engineers.

A phased set of strategic goals was developed to derive the greatest benefit from the industry move towards BIM while also managing technology and business process risk. The benefit of this approach is that USACE can focus on implementing near-term goals while also communicating intent and laying the groundwork for achievement of future goals. As BIM technology develops within the industry, these goals can be reviewed and adjusted to reflect the updated technology horizon. Appendix A contains a detailed listing of strategic goals and objectives. This section of the main report summarizes the major goals and objectives. Figure 1 depicts an important subset of the strategic goals and selected metrics on a timeline.

The goal of the first phase is to *establish an Initial Operating Capability (IOC) by 2008*. The intent is for the eight USACE MILCON Centers of Standardization to gain experience in using BIM models by implementing the technology on selected standard designs using available BIM technology (i.e., the Bentley ELA). The intent is **not** to apply BIM to all design work across the board. Some limited use of BIM on Civil Works projects will be encouraged as well. The focus is on achieving process improve-

ments through ***reusability*** of models. Objectives of this goal include setting up infrastructure (repositories), training personnel, creating standard BIM models, and beginning to use more automated engineering analysis capabilities available through BIM (e.g., structural, cost, etc.). The authors are fully aware of and expect that experience in achieving the IOC may lead to adjustments to the other strategic goals. One important consideration bears mention here. There is a choice to be made between developing in-depth BIM capabilities in-house, relying on contractors, or a mix of the two strategies. Regardless of the implementation approach, COSs will need to be familiar with BIM principles and effectively manage business process changes to take full advantage of BIM.

The second phase, *Establish facility life-cycle interoperability no later than 2010*, focuses on adoption of the National BIM Standard being developed by the National Institute of Building Sciences (NIBS). Adoption of this standard for USACE engineering activities will increase interoperability between USACE districts, customers, and contractors. Key vendors have already committed to the standard, which has been under development since 1995 by the International Alliance for Interoperability (IAI) as the Industry Foundation Classes (IFC). By participating in and helping to guide the NIBS NBIMS effort, USACE can ensure that the standard meets the requirements of the Army and Department of Defense. Adoption of this standard will decrease the reliance of USACE on any one vendor. Delivering facility designs and as-built information in the NBIMS standard will also significantly increase their value to USACE customers, who can use the models to automatically populate computerized maintenance management and asset management systems. Publishing the intent to adopt the NBIM standard will encourage the further development of NBIMS compliant software by vendors.

The third phase is to *"Achieve Full Operational Capability using NBIMS based e-commerce no later than 2012."* Armed with the experience of implementing BIM models in USACE's COS and selected Civil Works Districts, as well as adoption of the NBIMS standard, USACE will be in a position to dramatically improve business processes by using NBIMS as the principal e-commerce communication medium for contract advertisement, award, and submittals. The use of BIM will be expanded to all design and construction activities for which it is economically feasible, again based on experience gained in the preceding phases. It is anticipated that BIM tech-

nology will enable substantial automation of quantity take-off, scheduling, submittal checking, and code-compliance checking by 2012. This phase also includes a goal to routinely use NBIMS in asset and maintenance management, with seamless transfer of as-built, operations, and maintenance information to the customer (internal and external).

The final phase, "Leverage NBIMS to automate life cycle tasks no later than 2020" focuses on continuing to achieve substantial reduction in cost and time of constructed facilities. A number of promising technologies are emerging from universities and laboratories that will be able to leverage BIM. Examples include fabrication of building components from BIM models (already being used by some constructors), automated site adaptation of BIM models, automated construction site monitoring, point of use access to O&M documentation, and even robotic construction of facilities. These goals are considered tentative and will be pursued only if the technology develops sufficiently and offers a sufficient return on investment.

2.6 Short-Term Strategic Goals

Figure 2 shows the short-term plan to implement BIM at Corps Districts and Centers of Standardization in support of the Corps' interoperability goals.

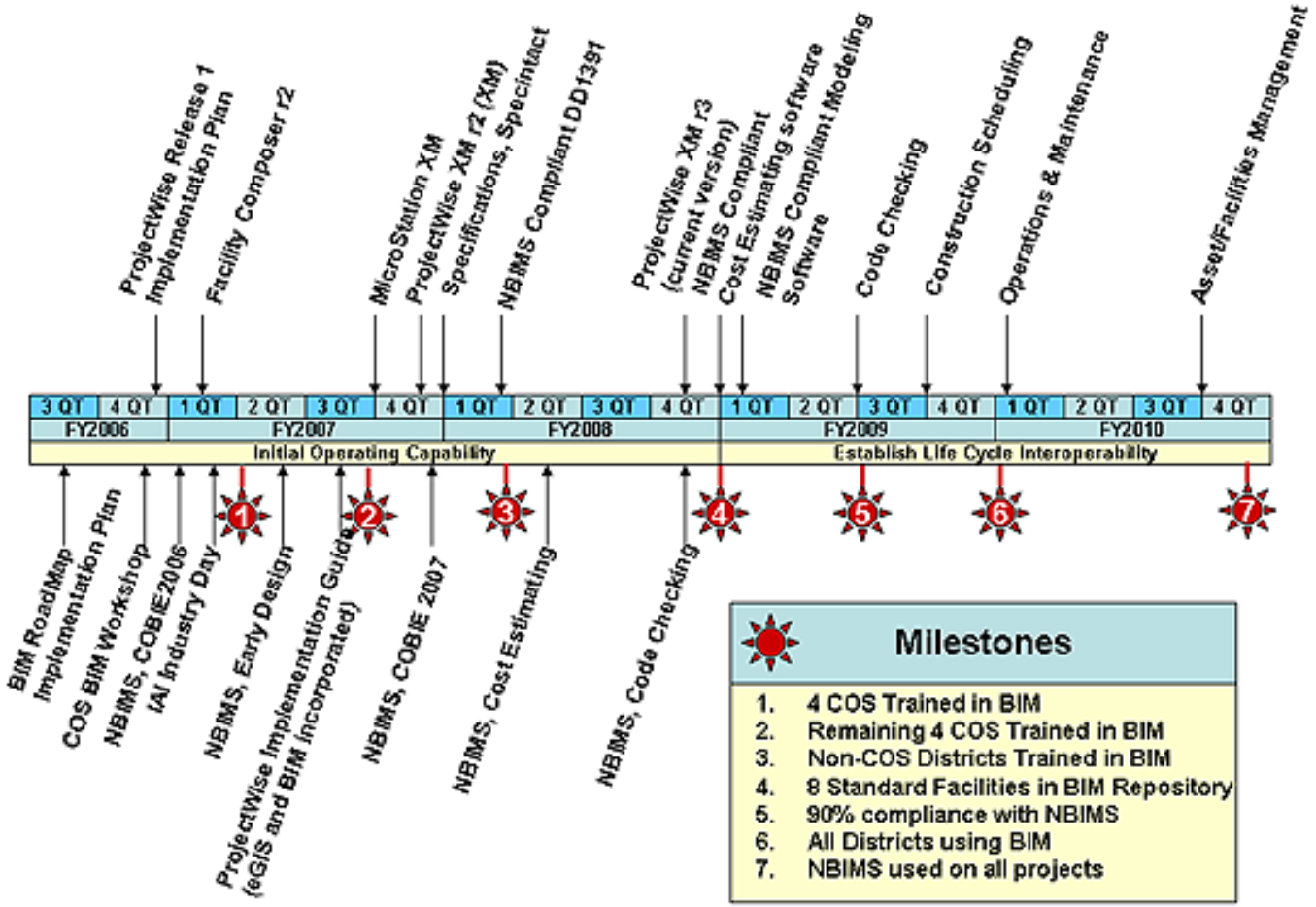

Figure 2. Short-term Plan for implementing BIM at Corps Districts and Centers of Standardization and supporting the Corps interoperability goals.

3 Conclusion

This work has outlined the strategic and implementation plans for using BIM technology to improve the planning, design, and construction processes of the U.S. Army Corps of Engineers, and how the U.S. Army Corps of Engineers will meet the vision of its DA proponents, including the Office of the Secretary of Defense (OSD), the Army, and the Air Force.

Detailed information for BIM support and implementation is provided in the appendixes to this report:

- Appendix A: Strategic Plan-Goals and Objectives (p 15)
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Glossary of Terms

Building Information Modeling (BIM) model

A Building Information Model (BIM) is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward

Cell

A cell is a type of object. It is saved in a specific format to allow ease of replication and reuse. There are three types of TriForma cells; parametric, compound and regular. They can be either 2D or 3D.

Charrette

An intensive process that involves the collaboration of all project stakeholders at the beginning of a project to develop a comprehensive plan or design. The U.S. Army Corps of Engineers Engineering and Construction Bulletin on DD Form 1391 Preparation Planning Charrette Process can be found on the Whole Building Design Guide's Construction Criteria Base at URL: http://www.wbdg.org/ccb/ARMYCOE/COEECB/ecb_2003_8.pdf

Component

In Triforma, components are materials that make up a part. For instance, a base plate part may consist of grout and steel plate components. A single component may be tied to many different parts. Component data can be used for quantity take-offs, specification sections based on CSI format and even cost data.

Data Group

A Data Group consists of specific spatial and text data connected to BIM objects contained in specific dataset folders. These same files contain the information that describes how this information is requested for each object and displayed in schedules.

Dataset

A Dataset is the information that describes the non graphical and graphical data tied to the objects within the BIM.

Deliverable

A Deliverable is the product of engineering and design efforts. Typically, this would be the concept submittal and the corrected final design. A deliverable may have multiple phases.

Design

"Design" is a general term for the efforts of the Engineering Division. For the purpose of this roadmap, it is limited to the preparation of plans, specifications, and design analysis. The design phase requirements will vary by project, as determined by the Acquisition Strategy Meeting. All plans and specifications developed shall be clearly identified as to the phase of design it represents.

Discipline Master Model

A "Discipline Master Model" refers to all the discipline-specific Floor Master Models referenced together to represent the structure.

Extraction

Extractions are cuts or views of the structure taken from Discipline Master Models. When the extraction is taken, a two dimensional view of the structure is obtained (floor plan, elevation, section, etc.). However, the extraction still contains links to the data embedded in the BIM model. If a change is made to the Discipline Master Model, the extraction will need to be regenerated.

Family

A family is an organized group of parts within the TriForma Dataset Explorer. The Corps of Engineers dataset organizes the parts into families based on constructions systems such as "Exterior Walls," "Doors," or "Spaces."

Floor Master Model

A "Floor Master Model" is a breakout of a structure's discipline-specific elements into floors. Breaking out a discipline's work into Floor Master Models allows architects/engineers to work simultaneously on various parts of a structure without waiting on another's work. For instance, one architect may begin working on the exterior shell of a building, while another architect works on the interior model of the first floor. If a structure is extremely complex, the need may arise to break the structure's Floor Master Models up into Zone Master Models.

Industry Foundation Class (IFC)

IFCs are data elements that represent the parts of buildings, or elements of the process, and contain the relevant information about those parts. IFCs are used by computer applications to assemble a computer-readable model of the facility that contains all the information of the parts and their relationships to be shared among project participants. The project model constitutes an object-oriented database of the information shared among project participants and continues to grow as the project goes through design, construction, and operation. The International Alliance for Interoperability (IAI) has created this IFC data exchange format. For more information on IAI see URL: http://www.iai-na.org/technical/faqs.php.

Interoperability

Interoperability refers to the exchange of information among project participants throughout the lifecycle of a facility by direct communication between software applications.

Lead Technician

The Lead Technician is the technician responsible for coordinating the efforts of all modelers and technicians within the model. The Lead Technician is selected for each project from the technicians assigned to a project and is generally from the same section as the PE/A. This person may also be called a “Lead Modeler.”

Level Library

A level library file is used during the boot up of TriForma by configuration files to attach levels required for all parts within a dataset. It does not replicate the seed file levels needed to comply with the A/E/C CADD Standard. It is provided to make sure that no parts are placed without the proper level.

Model File

In the BIM process, the Model File contains a referenced Extraction and model file-specific information. It is recommended that Extractions not serve directly as Model Files, since if Extractions have to be regenerated, all model file-specific information added to the Extractions will be lost. See the A/E/C CADD Standard for more information.

Module

A module is a collection of objects required for a specific Corps of Engineers space. The size of the module is base on the design guide programmed area, but it may be edited and manipulated for use within specific designs. All objects and elements in a module are modeled to conform to the A/E/C CADD Standard (see section "References"). The purpose of a module would be to reduce redesign effort by reusing previous modeled space modules. Examples might include restrooms, maintenance bays, arms vaults, conference rooms, and kitchens.

National Building Information Model Standard (NBIMS)

The Facility Information Council (FIC) of the National Institute of Building Sciences (NIBS) has formed a committee to create a National Building Information Model Standard (NBIMS). "The mission of the National BIM Standard Project Committee is to improve the performance of facilities over their full life-cycle by fostering a common, standard and integrated life-cycle information model for the A/E/C and Facilities Management industry. This information model will allow for the free flow of graphic and non-graphic information among all parties to the process of creating and sustaining the built environment, and will work to coordinate U.S. efforts with related activities taking place internationally." An online news story that describes the formation of the NBIMS Development Committee is accessible through URL: http://www.nibs.org/newsstory1.html

Object

An "Object" is a term used to describe an electronic element within a BIM model that represents a design element. It may be a 2D or 3D object and it must either have data connected to it (intelligent object) even if it is simply named for counting purposes or it can be a programmed to respond to input automatically (Smart Object) such as a parametric cell.

Part

Parts are the building blocks of a BIM. For example, doors and walls are parts of a building. Similarly, walls, slabs and pilings are parts of a flood control retaining wall. A part holds graphic and non graphic information about those objects. It contains component and extraction information. All Corps of Engineers Parts control and comply with the A/E/C CADD Standard (see section "References").

Project Engineer/Architect (PE/A)

The PE/A is an individual assigned as the technical manager responsible for day-to-day coordination of the design. The PE/A represents the design team on the project team.

Project Master Model

The "Project Master Model" is a compilation of all Structure Master Models plus possibly Civil DTM files referenced together. The Project Master Model File shows the entire project (e.g., all building Structure Master Models), rather than just a portion of the project (one building's Structure Master Model).

Seed File

A seed file is a file used to create a new file. A seed file is simply a file with as many default configuration settings completed for a project. The seed files provided in the Default Dataset have been created with the proper working units, color table, and many other settings complete. This does not mean that the seed file will have everything needed for all projects, but it is provided to clarify and simplify specific settings.

Sheet File

A sheet file is a CAD file that shows a selected view or portion of a Model File within a referenced border sheet. Sheet Files are used to generate the plotted construction sheets. See the A/E/C CADD Standard for more information.

Structure Master Model

The "Structure Master Model" is a compilation of all the Discipline Master Models referenced together. The Structure Master Model composes the entire structure.

Workspace

The "Workspace" is the framework in which a set of folders together with MicroStation, TriForma, and discipline application configuration files that are created to manipulate where and how TriForma records data and operates. This is used by the Corps of Engineers to gain consistent data when receiving BIM submittals and deliverables.

Zone Master Model

A "Zone Master Model" is a breakout of a structure's discipline-specific Floor Master Model elements into zones or quadrants. This is only recommended for extremely complex structures.

Acronyms and Abbreviations

Term	Spellout
A/E	architect/engineer
AEC	U.S. Army Environmental Center
ATFP	Anti-Terrorism/Force Protection (ATFP)
BIM	Building Information Model
CAD	computer-aided design
CADD	computer-aided drafting and design
CAFM	Computer-Aided Facility Management
CALS	CALS
CD	Compact Disk
CERL	Construction Engineering Research Laboratory
CMMS	Computerized Maintenance Management Systems
COBIE	Construction Operations Building Information Exchange
COE	Chief of Engineers
COS	Centers of Standardization
DA	Department of the Army
DARPA	Defense Advanced Research Projects Agency
DC	direct current
DISDI	Defense Installation Spatial Data Infrastructure
ELA	Enterprise License Agreements
ERDC	Engineer Research and Development Center
ERDC-CERL	Engineer Research and Development Center, Construction Engineering Research Laboratory
ERDC-ITL	Engineer Research and Development Center, Information Technology Laboratory
ESRI	Environmental Systems Research Institute, Inc.
FAC	Field Advisory CADD
FIC	Facility Information Council
FOC	Full Operational Capability
GB	gigabyte
GFEBS	General Fund Enterprise Business System
GIG	Global Information Grid
GIS	geographic information system
GSA	General Services Administration
HQUSACE	Headquarters, U.S. Army Corps of Engineers
IAI	International Alliance for Interoperability
IBC	International Building Code
IE	Internet Explorer
IFC	Industry Foundation Class
IOC	Installation Operations Command

Term	Spellout
IT	Information Technology
ITL	Information Technology Laboratory
JTF	joint task force
LRL	Louisville District
LSS	Life-cycle Solution Service
MB	megabyte
MCACES	MCA Cost Estimating System
MILCON	Military Construction
NBIMS	National Building Information Model Standard (NBIMS)
NIBS	National Institute of Building Sciences
OJT	On the Job Training
OSD	Office of the Secretary of Defense
PDF	Portable Document Format
PDT	Project Delivery Team
PE	Program Element
PE/A	Project Engineer/Architect
PM	particulate matter
POC	point of contact
QA	quality assurance
QC	quality control
QC/QA	quality assurance/quality control
RAM	random access memory (RAM)
RFP	request for proposal
ROI	Return on Investment
SDI	Sustainable Development Indicators
SMS	Sustainment Management Systems
TBA	to be announced
TEN	Technical Excellence Network
TF	TF
TR	Technical Report
URL	Universal Resource Locator
USACE	U.S. Army Corps of Engineers
WWW	World Wide Web

Appendix A: Strategic Plan-Goals and Objectives

Contents

Goal 1: Establish Metrics To Use for Measuring Process Improvement

1.1 Objective: Create Lean Six Sigma for Building Information Modeling process

Coordinate with MILCON Lean Six Sigma project

Coordinate with Civil Works LSS

Further guidance on capturing metrics will be forthcoming as metrics are defined in the Lean Six Sigma project for MILCON and Civil Works.

The key to success in implementation of BIM is not to simply automate existing processes, but rather to create a new leaner business process enabled by BIM technology. Three key principles apply:

- Capture and reuse facility models as Building Information Models.
- Minimize transmission and translation delays by specifying User Exchange Requirements.
- Maximize automation of mundane tasks.

1.2 Objective: Capture Metrics from BIM projects

Goal 2: Establish Initial Operating Capability for BIM No Later than 2008

Focus: Reuse of BIM models for faster planning and design

Metric: 15 percent reduction in planning and design time and cost

2.1 Objective: Achieve focused expertise in MILCON Centers of Standardization (COS)

Metric: Eight COS trained and productive in BIM by 2008

As stated in the "Realignment/Establishment of Centers of Standardization (COS)" memorandum, dated 6 March 2006, signed by Brigadier General Merdith W. B. Temple, the COS will be responsible for developing and maintaining Building Information Modeling (BIM) models for standard facility types. Each COS will manage the BIM implementation process, develop, deploy, and maintain their standard BIM datasets, and communicate BIM requirements to their A-Es. A copy of this memorandum can be found in Appendix H.

The following objectives and implementation plans are provided to help outline the BIM direction for the Corps of Engineers.

2.1.1 Create district team
2.1.2 Provide software and training (use Enterprise License Agreement with Bentley Inc.)
2.1.3 Target facility type and projects
2.1.4 Build expectations and buy-in with facility standard proponent
2.1.5 Proponent roles and responsibilities
2.1.6 Build expectations and buy-in with user organization
2.1.7 Mission critical facilities management
2.1.8 Build strong and long-term AE relationships with firms using BIM
2.1.9 COS will develop common shared BIM models (place in repository)

2.2 Objective: Establish BIM capability at remaining geographic districts (civil and military)

Metric: One BIM per geographic district by 2008, this can be in-house or A-E contracted with district oversight

2.2.1 Create district team
2.2.2 Provide BIM training (use ELA)
2.2.3 Provide guidance on use of facility standards BIM repository
2.2.4 Provide A-E oversite guidance on BIM related projects
2.2.5 Target projects
2.2.6 Identify and build relationships with clients that have O&M requirements
2.2.7 Build strong and long-term AE relationships with firms using BIM
2.2.8 Provide BIM models to clients

2.3 Objective: Develop enterprise repository(ies) for BIM

Metric: Repository will contain a minimum of eight facility types in BIM by 2008; initial focus will be on facilities in the MILCON Transformation

2.3.1 Corporate data/models (USACE)

Corporate data will contain models that are standard across USACE.

2.3.2 Facility standard models/modules (COS)

COS repositories will contain standard's models and modules for the facility type that the COS are responsible. Facility standard models contain references to corporate models.

2.3.3 Project models (District)

Project models are specific to a particular project and may be based on corporate and facility models.

2.4 Objective: Prepare standard facility types for adapt/build reuse using best design/construction practices from BIM transformation projects (DB-RFP projects)

Metric: Eight standard facilities in BIM by 2008 (minimum of one facility per Center of Standardization [COS])

2.4.1 Develop computable facility standard requirements/program (Facility Composer, Early Design National BIM Standard)
2.4.2 Capture best design practices in BIM models from designers (with regional variations)
2.4.3 Develop contract language for use in acquisition, including description of BIM submittal requirements

Prior to 2008, submittal documents will contain the proprietary data exchange standard (.dgn, .dwg). When the National BIM Standard is further developed, submittals will be delivered in the form of IFC compliant/NBIMS compliant models.

2.5 Objective: Use BIM models in Planning/Design Charrettes

Metric: COS use BIM in at least one Planning Charrette and one Design Charrette by 2008

2.5.1 Plan facility using computable facility standard requirements/program
2.5.2 Adapt-build using completed standard BIM models/modules
2.5.3 Capture metrics

2.6 Objective: Conduct automated design analysis using BIM

Metric: Used on 50 percent of projects

2.6.1 Required analysis
2.6.1.1 BIM model quality assurance checking
i. *Dataset element validation*
ii. *Visual validation*
2.6.1.2 Interference detection (model interference checking)
2.6.1.3 A/E/C CADD Standard compliance
2.6.2 Additional analysis (optional)
2.6.2.1 Structural analysis
i. *NBIMS is planning to include CIMsteel Integration Standards, Release 2 (CIS/2) as the National Structural BIM Standard*
2.6.2.2 Cost estimation

Bentley Systems is meeting with Project Time and Cost, the developers of MCACES Version 2 (MII) , 4Q 2006, to develop a BIM interface with Triforma product and MII. Bentley has also invited five other commercial cost estimating software developers to join the Bentley Developer's Network for free.

2.6.2.3 Code compliance (system dependant)

The NBIMS Development Team is working on a phased approach to provide first order automated code checking. A demonstration of Industry Foundation Class (IFC)-compliant design checking for International Building Code (IBC) energy compliance and accessibility is currently planned for the International Alliance for Interoperability (IAI) "Industry Day" (Nov 2006). The demo will include a link to DrChecks. As code violations are found, they will be posted as code compliance review comments in DrChecks for resolution tracking.

2.6.2.4 Anti-Terrorism/Force Protection (ATFP) analysis (Defense Advanced Research Projects Agency [DARPA] Immune Building Program's Immune Building Toolkit, Builder 3.0 ATFP Checker) (use-dependant)

Goal 3: Establish Facility Life-Cycle Interoperability No Later than 2010

Focus: Interoperability using National BIM Standard (NBIMS), Must ensure that USACE requirements are met with NBIMS

Metric: 90 percent Compliant with National BIM Standard

3.1 Objective: Ensure that National BIM Standard meets the requirements of USACE and our customers

3.1.1 Participate in and guide National BIM and geospatial standard meetings

3.1.2 Participate in demonstration projects to test standard

3.1.2.1 Early design

3.1.2.2 Builder 3.0

3.1.2.3 O&M: Construction Operations Building Information Exchange (COBIE)

3.2 Objective: Use NBIMS to control cost, quality and validation of design, construction, and O&M submittals

Metric: Define and demonstrate capability

3.2.1 Define proponent's requirements using NBIMS

3.2.2 Validate submittals against proponent's requirements using NBIMS

3.2.3 Validate construction submittals

3.2.4 Validate as-built/commissioning submittals

3.3 Objective: Establish interoperability with life-cycle information technologies

3.3.1 Project programming and approval (DD Form 1391)
3.3.2 Planning and design tools
3.3.3 Cost estimating
3.3.4 Specifications
3.3.5 Construction scheduling (CPM)
3.3.5.1 Simulation (4D)
3.3.6 Collaboration tools
3.3.6.1 Design review and checking
3.3.7 Ensure interoperability between NBIMS and GIS (Army and Corps)
3.3.8 Enterprise portal (document management)
3.3.9 Operations and Maintenance
3.3.9.1 Computerized Maintenance Management Systems (CMMS)
3.3.10 Asset Management
3.3.10.1 General Fund Enterprise Business System (GFEBS)
3.3.10.2 Sustainment Management Systems (SMS)
3.3.10.3 Computer-Aided Facility Management (CAFM)

Goal 4: Achieve Full Operational Capability Using NBIMS Based e-Commerce No Later than 2012

Focus: Use of NBIMS as part of contract advertisement, award, and submittals

Metric: NBIMS used for all projects

4.1 Objective: Expand number of NBIMS-based models

Metric: All standard designs in BIM

4.2 Objective: Conduct business transactions using NBIMS

Metric: All medium to long term sustainable projects will use NBIMS

Medium-long term sustainable projects are projects that will be maintained over many years and will reap the benefits and ROI of BIM.

Goal 5: Use NBIMS in Asset Management and O&M of Facilities no Later than 2012

Focus: Computerized Maintenance Management and Asset Management per President's Management Strategy

Metric: Demonstrate substantial ROI for clients

5.1 Objective: Seamlessly transfer NBIMS information into computerized maintenance management systems
5.2 Objective: Scheduling of maintenance actions based on NBIMS

5.3 Objective: Repository for O&M documentation (commissioning and client)
5.4 Objective: Point of service access to O&M information (e.g., RFID, IBR)

Goal 6: Leverage NBIMS To Automate Life Cycle Tasks No Later than 2020

Focus: Identify downstream technologies to leverage investment in the NBIMS data

Metric: Substantial reduction in cost and time of constructed facilities

6.1 Objective: Fabricate components from NBIMS data
6.2 Objective: Automate site adaptation of standard facilities
6.3 Objective: Automate construction site progress monitoring
6.4 Objective: Robotically construct facilities based on NBIMS model

Appendix B: BIM Implementation Plan for the U.S. Army Corps of Engineers

Contents

1. BIM Vision/Introduction

Why the sudden push to move to Building Information Modeling (BIM)? Well, just as computer-aided design (CAD) was a giant leap from hand drafting, so too is BIM a giant leap from CAD. This BIM Implementation Plan addresses what the Centers of Standardization, Districts, Divisions, and Laboratories can do to successfully implement BIM, as well as how to implement the Building Information Modeling Plan.

2. Why Are We Doing This?

While it seems like BIM has only recently appeared, the use of BIM has actually been growing for quite a few years. Federal agencies, such as the U.S. Coast Guard and General Services Administration, are using BIM with success. A-E firms are also making the switch from CAD to BIM in astounding numbers. The failure of the Corps of Engineers to exploit this technology in favor of traditional CAD will diminish the Corps' competitiveness and technical prowess. Therefore moving to BIM is not an option for the Corps of Engineers, *it is a necessity*.

Some important things to keep in mind about BIM are:

BIM addresses the complete life-cycle of a project. While CAD addresses design, construction, and as-built documents for a project, BIM addresses a project from concept to construction through facility management, and renovation/demolition. BIM truly embraces the "cradle to grave" philosophy in the construction of facilities.

BIM is not just a 3D package. With BIM, you can create 2D and 3D drawings that are truly intelligent. No longer are you working with just lines, circles, and arcs. You are now working with walls, doors, and windows that **know** they **are** walls, doors, and windows.

BIM is not just "CAD + GIS." True, there are data attached to a BIM model and you can do queries to explore the information as you can with GIS. However, BIM model elements know what they are, what their characteristics are, and can simulate the element's actual behavior.

BIM gives power back to designers. With BIM, architects and engineers truly design in a virtual environment and see designs come together with great success. The designers are actually designing systems and assembling the data that supports these systems, not just placing graphics.

BIM means a complete set of information, not just a single drawing. The BIM model includes all aspects of the building: plans, sections, schedules, elevations, and details. However, not just one person is putting in all the data. There is a "data evolution" that occurs through the life cycle of the project. The organization and reproduction of this information on another system (when turning the project over to the client) will be an important part of the BIM organization.

BIM models are not interchangeable between BIM software packages. Currently, the BIM model produced by one software package will not translate fully into another vendor's software. The graphics and data can be converted, but the parametric features of objects within the model will not be supported, thus limiting the use of the data after translation. This is similar to when CAD packages like AutoCAD, Graphisoft, and MicroStation were not easily shared. The vendors are aware of this issue and are working to make BIM models interoperable.

3. The Quandary

So how do we convince designers that are comfortable with 2D (and possibly 3D) CAD to move to BIM? Any time people are forced to change or adapt to new concepts or technology there is going to be resistance. For those who can remember, there was a heavy resistance to CAD. It took several years for people to see the value and savings that resulted from the use of CAD technology. Ask most users whether they would give up their current CAD application to return to hand drafting and you would probably have a fight on your hands.

Do not expect managers or CAD users to immediately embrace BIM. Keep in mind that the consumers of this data will not just be the people who deal with the 2D CAD drawings. True, those users will benefit from BIM, but the data that can be gleaned from the BIM model will also feed many systems and users.

What is Needed and What Must be Recognized. For a BIM implementation plan to succeed, there are certain requirements that are needed, opportunities that are available, and myths that need to be dispelled about BIM.

Requirement: Leadership Buy-in on BIM is Crucial. If you do not have management support on adapting to a new technology or process, the effort typically fails. The U.S. Army Corps of Engineers Headquarters is

championing the move to BIM in the Corps. Now it is up to management across the Corps to take on the challenge. So, what should management goals concerning the move to BIM be?

Expectations. Realize that BIM is an iterative process. Do not immediately expect a full blown BIM product on the first project that can be used throughout the whole project life-cycle. With any new process or technology, you have to learn to "crawl before you can walk."

Metrics. Set up metrics for success with your BIM projects. Define realistic goals for your first BIM model. On your next project expect more. Most importantly, define what your client wants from the BIM process. After each project, analyze your analysis your successes and discuss with your client.

Opportunity: BIM Provides an Opportunity for Change in Process versus "It's Just Another Tool." One misconception about BIM is that it is just a tool or just another CAD package. BIM is actually a process where a model is created that contains information required to answer queries across the life-cycle process. The BIM data goes beyond the design process and is augmented throughout the project's life–cycle – particularly the operations and maintenance phase.

Opportunity: Teamwork. In the development of a BIM model, the placement of actual construction elements instead of symbolic representations of elements makes the creation of a design very quick. This, accompanied with the power of immediate and constant visualization, provides for a high level of communication leading to the ability for quick design decision making. If a BIM team is sequestered in one location, the process will allow for teams to work on design issues together, removing communication problems inherent in current CAD design practices. This new teamwork concept may lead to increased labor charges early in the project, but will also lead to shorter project schedules.

Myth: Moving to BIM Means a Loss of Valuable Experience. Most people think that by moving to BIM, you are losing all your 2D and 3D modeling skills. This belief could not be farther from the truth. Most BIM software packages run on top of CAD software platforms, so 2D and 3D CAD skills will enhance the development of BIM models.

Myth: BIM Is Just for Buildings. The misconception is that BIM does not apply to structures such as locks and dams, since it "only works for vertical construction." This is not true. Any Civil Works project can also be created as a model in BIM. Once created, that BIM model will contain more information than any ordinary CAD drawing. Also, BIM has proven to provide a positive Return on Investment (ROI) to the building industry. Applying this concept to Civil Works projects, especially those that include multiple disciplines, will provide an even greater ROI to the Corps for two reasons. First, we are our own customer in this scenario. The most difficult piece of the puzzle in BIM is determining what data to track for O&M. With Civil Works projects, we have the legacy data and can easily determine the most beneficial data to model. Second, the life cycle of these structures are significantly longer than those in the building industry and offer a substantial ROI over their design life.

Myth: BIM makes designing much harder than with CAD. The entire process of drawing objects such as doors, windows, and walls takes much less effort than with CAD. The number of steps to create these elements will be greatly reduced with BIM. By putting in intelligent data, new data can be generated easily, such as schedules, plans, elevations, sections, details, and reports.

Myth: BIM is simple. After reading the previous myth, this probably sounds like a paradox. What this means is that since BIM uses pre-built objects for manipulation, the user is more dependent on the software providing all the necessary objects that will be needed in the facility or structure. However, on almost every facility or structure there will be some objects that are not a part of the standard BIM package. Therefore, a few people with advanced training on creating objects will be required to avoid the workflow problems associated with these types of issues.

Myth: **BIM has to be a database**. True, however there are many types of databases – federated and non-federated. BIM data can be contained in a single file, set of files, or full-blown shared database (relational or object-oriented).

4. Purpose

As an appendix to the Strategic Plan, this implementation plan is intended to be a guide to a Corps of Engineers district or design team in the implementation of Building Information Modeling. This plan will help a site begin the building of a BIM team from the management level to the individ-

ual modeling positions. It is designed to cover the initial hurdles in making BIM an integral part of the design process of the Corps of Engineers. The use of BIM as a planning, design, construction, and O&M tool promises great benefits. These benefits will be realized by not only the Corps, but also the Corps' customers.

5. Applicability

This document is intended for use by all Corps of Engineers districts and divisions who have chosen to respond to the BIM initiative set forth by Corps Headquarters. The BIM Implementation Plan has been developed for use by all team members involved in BIM. The initial audience is assumed to be Engineering Management and CAD Managers, but one of the greatest strengths of BIM is its communication tools, resulting in benefits for Project Managers, Designers, and the technical workforce as well.

6. Implementation Plan Guideline

The introduction of BIM into the Corps of Engineers business practices requires a well defined implementation plan. The plan should consider changes in the business process, changes in workflow, reassignment and relocation of staff, and a temporary decrease in productivity.

Any implementation plan must begin with leadership buy-in and commitment. BIM requires complete commitment from management, project leaders, and designers. There will be losses in productivity during the initial implementation of BIM. However, that productivity will quickly recover and eventually exceed current levels of productivity.

The following presents recommended steps for sites that are just starting to implement BIM. Because all Districts and Centers of Standardization vary in size and organization, it is possible that deviations may need to be made from this plan.

6.1 Set up a Transition to BIM Team

1. Who should be on this Transition to BIM Team?
   a) *Sponsor* – The Sponsor should be either the Chief of Engineering. The Chief of Engineering may designate someone to serve as the Sponsor, however that individual must be someone with the authority to create positions and set office priorities.
   b) *Senior Designer* – The Senior Designer should be either the Design Branch Chief or the Architectural Section Chief. This person should

be able to handle workloads, project schedules, and personnel assignments.

c) *Current CAD Manager*

2) What are the responsibilities of the Transition to BIM Team?
   a) Designating a project to be modeled using BIM technology
   b) Assigning an Implementation Team (this team should include):
      i) BIM Manager (for more information on this position, see the section "BIM Team Organization")
      ii) CAD Manager
      iii) Lead Technician (for more information on this position, see the section "BIM Team Organization")
      iv) Architect
      v) Mechanical Engineer
      vi) Structural Engineer
      vii) Electrical Engineer
      viii) Civil Engineer.
   c) Organizing and creating a BIM action plan:
      i) Set metrics
      ii) Set expectations (what are the District's vision and expectations for BIM?)
      iii) Clearly communicate the BIM vision to the Design team staff
      iv) Assign workload allocations to accommodate the Implementation Team's needs
   d) Mentoring and supporting the process.
   e) Communicating results and metrics to Corps Headquarters:
      i) Populate the Technical Excellence Network (TEN) site with milestone achievements (https://ten.usace.army.mil)
3) Degree of effort: 15 man days

6.2 Initiate the Implementation Team

1) Select a BIM Manager
   a) BIM Manager Training Prerequisites (for further information, see the section "Training")
      i) Managing MicroStation
      ii) Basic MicroStation
      iii) Administering Bentley ProjectWise
      iv) Network administration security course (govt)
      v) If available/practical, attend another District or COS's BIM workshop or BIM Manager workshop
      vi) Join the BIM Sub CoP

vii) Request to join USACE BIM Dataset Help Groove site (deals with technical issues regarding datasets or software).

b) BIM Manager Tasks
   i) Manage the BIM implementation process
      (1) Managing the meetings
      (2) Facilitating the "BIM Pit" (for further information, see the section "BIM Team Organization"
   ii) Communicating the BIM vision. This can be done through:
      (a) Brownbag meetings
      (b) Presentations
   iii) Deploying/Developing/Maintaining the District/COS Dataset
      (1) Acquiring the Corporate Template Dataset from ERDC
      (2) Communicating dataset changes back to ERDC
         (a) ERDC will evaluate the changes
         (b) ERDC will determine whether changes need to be added to the Corporate Template Dataset
         (c) ERDC will QC the changes
   iv) Serving as the POC for all external BIM-related issues
      (1) A-E coordination

2) Coordinate/schedule the BIM Workshop (for more information, see the section "Training")
   a) Set workshop/project expectations
      i) What disciplines are involved?
      ii) How far are they going to take the BIM model?
      iii) What output is anticipated (plans, elevations, schedules, QA, etc.)
   b) Scope the workshop
      i) Determine length and type of workshop (3 or 5 weeks)
         (1) Discuss with Corps Mentor/ERDC
         (2) Contact Bentley ELA coordinator (https://tsc.wes.army.mil/BentleyELA/)
      ii) Submit ELA request regarding workshop
   c) Assign students (10-12 students maximum)
      i) Who should the students be?
         (1) Project designers
         (2) Lead Technicians
            (a) Responsible for project output (contract docs, specifications, quantity reports, QA, renderings, etc.)
         (3) Draftsman
            (a) The Draftsman positions are for people pursuing Lead Technician positions

(4) BIM Manager
(5) CAD Manager

3) Degree of effort
   a) 30 man days for the BIM Manager training
   b) 80 man days for BIM Manager oversight
   c) 175 man days maximum for BIM Workshop(s) (12 students x 15 days) (more for the 5-week training option)
   d) 2 hours per week for Implementation Team meetings
   e) OJT (On the Job Training) productivity loss – approximately 12 weeks
4) Cost of effort (Note: these are estimated costs, could be more or less depending on the COS or District)
   a) Training costs – not applicable, since training can be acquired through the use of ELA credits
   b) BIM Manager - $150K in labor costs
   c) Other costs - $75K - $100K, these include:
      i) Lost productivity
      ii) Dataset coordination, development, and implementation
      iii) A-E team coordination

7. Training

Successfully introducing BIM into the design process requires technical training and organizational changes. As of FY06, the U.S. Army Corps of Engineers has an Enterprise License Agreement (ELA) with Bentley Systems. The ELA provides the Corps with access to nearly all of the Bentley products through FY08 (for this reason, the Implementation Plan focuses primarily on Bentley products. When the ELA is up for review in FY08, hopefully all BIM applications will be IFC-compliant and interoperability will be greatly improved). The ELA also provides each district with training credits that can be used to obtain free training from Bentley. This training includes both standard classes as well as Corps-specific training/workshops. BIM workshops are available within the ELA and are highly recommended for organizations implementing BIM for the first time. Complete details on the ELA are available from the CADD/GIS Technology Center's web site at URL: https://tsc.wes.army.mil/BentleyELA/. Request forms, Bentley contact information, and training descriptions are also available from the site.

Prerequisites: Some commercial BIM applications are based on existing CAD packages. For example, Bentley's architectural BIM package, called Bentley Architecture, requires a strong background in Bentley's MicroSta-

tion (the same holds true for the structural (Bentley Structural), mechanical (Bentley Building Mechanical Systems), and electrical (Bentley Building Electrical Systems) BIM packages). A "strong background" means that the user must have completed training on the latest version of MicroStation and have a working knowledge of 2D design techniques and AccuDraw. For users that have no background or limited experience with MicroStation these courses are recommended:

- **Essential MicroStation** –This course is designed for the new MicroStation user and builds a solid foundation in the concepts, tools and features found in the MicroStation drawing environment.
  http://bentleyinstitute.bentley.com/courseinfo.aspx?course=TRC001310-1/0001
- **Moving to MicroStation** - This course is designed for experienced CAD user who wants to transition existing CAD knowledge from other vendor products to MicroStation skills. Plotting and other output considerations are covered, including pen table development and usage.
  http://bentleyinstitute.bentley.com/courseinfo.aspx?course=TRC001310-1/0001
- **Delta Training** – (Open) MicroStation V8 (or latest version) User Update (1-day training)

BIM Workshops: BIM Workshops consist of on-site training followed by coaching. This approach allows students to train on the BIM applications and immediately use the product on a real project with instructor support and oversight. Within the Corps, this approach has had great success and is strongly recommended. (In situations where no project exists, this approach is still useful when used with a practice project.)

The Bentley ELA provides a standard 3- or 5-week BIM workshop and an optional customized workshop based on specific project needs or for offices with past experience in BIM.

- **5-week BIM Workshop** – For sites with no BIM experience, the 5-week BIM Workshop is recommended. The Workshop includes training on Triforma, Navigator, Visualization, and Parametric Cell Studio. It is strongly recommended that this workshop be conducted in concert with a new BIM project and supported by management. This training is a standard ELA workshop.
- **3-Week BIM Workshop** – For sites familiar with BIM applications, the 3-week workshop offers abbreviated training or abbreviated coaching at the discretion of the site. This training is a standard ELA workshop.

- **Customized Option** – The ELA allows any Corps site to request a customized BIM workshop from Bentley. This training is often used by the Corps' Centers of Standardizations that require specific support in developing BIM models to be provided as part of Design/Build contracts or receiving BIM models as completed projects. This training option is available through the ELA.

BIM Manager Training: BIM implementations require some staffing changes or reassignments. The critical staff member is the BIM Manager. (See the section "BIM Team Organization" for more on the roles and responsibilities of the BIM Manager.) Training requirements for the BIM Manager (available through the ELA) include:

- **Managing MicroStation** - This is a comprehensive course for managers of multi-user MicroStation-based [or hybrid] CAD installations. This course examines in detail the tools and procedures that allow complete control over the installation, appearance and operation of MicroStation. Running throughout the course is the development of a prototypical CAD work environment constructed step-by-step as each topic is discussed. Course descriptions are available at the Bentley Institute website at URL:
  http://bentleyinstitute.bentley.com/courseinfo.aspx?course=TRC002750-1/0001
- **Administering Bentley ProjectWise** - This course covers configuration and administration of the Bentley ProjectWise Engineering Content Management solution. It is primarily focused on the day-to-day tasks associated with document and project management and covers BIM specific implementation issues. Depending on the site, more implementation team members may want to take this training. Course descriptions are available at the Bentley Institute website at URL:
  http://bentleyinstitute.bentley.com/courseinfo.aspx?course=TRC002770-1/0001

Corps-specific training on datasets: The Corps is pursuing developing a Corporate Template Dataset of objects that will be distributed via ProjectWise. The training for using and submitting new datasets will be developed by ERDC. Release date TBA.

Discipline-specific training: After the initial implementation of BIM at a site, discipline-specific training for new employees or refresher training on new releases of application software can be obtained through the ELA.

Course descriptions are available at the Bentley Institute website at URL: http://bentleyinstitute.bentley.com/catalog.aspx?discipline=5

Corps-specific Workshops: Additional workshops for the Corps will be developed and provided to the Corps as needed (e.g., Merging BIM with InRoads, Migrating BIM data with GeoGraphics, BIM and ESRI).

Additional User Training: The Corps is implementing ProjectWise as the preferred collaboration tool. ProjectWise User training will be required at every district. Training is available though the ELA as classroom, online, and self paced.

- **Project Manager Training:** Only the technical design team has been considered thus far. As mentioned earlier, "BIM is a change in process." BIM will affect business plans and District-level data expectations; therefore, the entire PDT must be accounted for with training. Project Managers (PM) must have a level of training that enables them to set proper expectations of their in-house and A-E BIM teams. This can be accomplished with "brown bag" sessions, but more formal training should be considered.
- **A-E Orientation:** Assuming that the in-house District team is trained, time should be spent preparing the A-E firms that will do district work with the USACE BIM Workspace. The BIM Manager should be ready to provide the facility type specific default data to A-E firms and be able to guide them in the use of the data template.

8. Environment

8.1 Software/System Configuration and Requirements

The Corps-recommended minimum system requirements for a BIM workstation are (Note: In compiling these requirements, the following BIM products were researched: MicroStation TriForma, Bentley Architecture, Bentley Structural, and Bentley Building Mechanical Systems):

- CAD Software required: MicroStation version 08.05.02.35
- BIM Software:
  - TriForma version 08.05.03.70
  - Architecture version 08.05.03.56
  - Structural version 08.05.03.62
  - Mechanical version 08.05.03.49
  - Electrical version 08.05.03.10
  - Navigator version 08.06.01.24

- Operating System: Windows XP Professional version 2002 SP2
- Processor: Intel Pentium 3.2 GHz Dual Core
- Internet Explorer: IE 6.0.2900 SP2
- Video: NVIDIA Quadro FX 3450/4000 SDI - 256 MB Video RAM
- Memory: 1.5 GB RAM
- Hard Disk: 150 GB
- Dual 20-in. Flat Panel monitors
- Network Adapter: Intel Pro 1000 MTW network connection
- 1 GB Bandwidth network (25 percent of modelers presently)

Note: MicroStation TriForma, Bentley Architecture, Bentley Structural, and Bentley Building Mechanical Systems are all available under the Bentley ELA with the U.S. Army Corps of Engineers. For more information, visit https://tsc.wes.army.mil/BentleyELA/

9. BIM Team Organization

Just as the shift from CAD to BIM requires some adaptation and adjustment, so too does the development of a BIM Team. Most sites' immediate reaction will be to place their CAD Manager in as the lead BIM coordinator. However, based on experiences using BIM at other sites, this is not the best way to implement BIM. At each site, there are three duties related to BIM: BIM Manager, Lead Technician, and Designers.

9.1 BIM Manager

Each site needs to designate someone to serve as the BIM Manager. For the first 6 months of implementing BIM, this person should be allowed to devote 100 percent of their time to the BIM implementation. Depending on the BIM workload after 6 months, this may taper off to 50 percent. However, if the BIM workload is heavy, the BIM Manager time dedicated to BIM should remain at 100 percent. As mentioned above, the first instinct is to designate the current site CAD Manager as the BIM Manager as well, but this should be avoided at all costs, due to the time required in implementing BIM. If the CAD Manager is ultimately designated to serve as the BIM Manager, then the CAD Manager's work needs to be assigned to another person. The person appointed to be the BIM Manager should also not be someone who has production responsibilities at the site. An example Army Job Description for a BIM manager is attached in Appendix G. This is only an example and should be modified for specific district requirements.

The BIM Manager's duties include (these will stay the same throughout all life-cycle phases):

- Coordinates the "BIM Pit"
- Arranges for BIM training
- Configures and upgrades BIM related datasets
- Provides data evolution into the project-centric dataset and ultimately the corporate template dataset (if necessary)
- Arranges design reviews.

9.2 Lead Technician

Designating someone to be a Lead Technician at a site is highly recommended. Again, the person assigned to be the Lead Technician should not be the same person assigned to be the BIM Manager. Also, Designers should not take on Lead Technician duties. Keep your Designers designing. Note: The junior Architect or Engineer could take on the Lead Technician duties.

The Lead Technician's duties include:

- Managing the model
- Handling extractions/quantity take-offs/spec generation from the model
- Ensuring that all BIM work follows the A/E/C CADD Standard and the National BIM Standard
- Ensuring data quality assurance by using quality reporting tools.

9.3 Designers

The Designers are the architects and engineers assigned to design the BIM model. These will be the people coordinating work in the "BIM Pit." One thing to keep in mind is that drafters should not be designated as Designers. In BIM, design decisions are constantly and rapidly being made, so you want the architects and engineers to be the people doing the work, rather than them just telling a drafter what needs to be changed in a model.

The Designer's duties include:

- Being responsible for design requirements for his/her design discipline
- Executing the design and design changes in a 3D environment.

9.4 "BIM Pit"

The "BIM Pit" (as nicknamed by Louisville District) is an environment where the architects and engineers are in a single room collaborating at the same time on a BIM model. This is where all the immediate communication and collaboration on the BIM model will occur. This is a fundamental shift in design philosophy within the Corps, since typically the disciplines are physically located in separate areas, each working on their own part of the design. Networked desktop computers should be set up for each Designer in the BIM Pit with access to a projector, whiteboard, and conference phone. This BIM Pit should be comfortable for all the Designers to work in, with access to both the model and the Internet. The ultimate goal of the designers when they leave the BIM Pit is to have a 50 percent design and drawings in hand.

9.5 Additional Lessons Learned

Some other lessons learned from successful BIM implementations with regard to the BIM team organization:

- The skill set of the person selected to be a BIM Manager, Lead Technician, or Designer is not as important as their attitude. If you have designated someone who is not 100 percent involved in learning BIM, or could care less about collaborating on a design, **replace them**. BIM is a great new opportunity for Corps sites; do not bring down your site's BIM efforts by placing someone in there that does not care about the ultimate implementation goal.
- Get your people serving as BIM Manager, Lead Technician, and Designers trained as soon as possible. Then get them involved **immediately** on a project. The most ideal situation would be to use the project as the project exercises during the training. Once the team has trained in BIM and completed an actual project, those people should be used as mentors for the next batch of Designers at your site. That way, skills and lessons learned are being passed on from one team to the next.

10. Standards, Configurations, and Datasets

The A/E/C CADD Standard and BIM

Even though BIM is much more than a 3D package, BIM typically provides 2D data that should be compliant with the A/E/C CADD Standard. However, the question is, does the A/E/C CADD Standard meet the needs of BIM users? To an extent it does. However, the A/E/C CADD Standard is being augmented to accommodate certain BIM/3D aspects. For instance,

in a 3D view of the BIM model, many items may not be compliant because there currently is no guidance in the A/E/C CADD Standard for 3D objects. However, since the output from a BIM model will be a bid set of 2D drawing sheets, the A/E/C CADD Standard is extremely relevant and is required by the Corps.

How do we ensure that the A/E/C CADD Standard is meeting the needs of BIM users? Currently, the Center is developing a BIM comment submittal site similar to the A/E/C CADD Standard comment site. However, it is recommended that the National Institute of Building Sciences' current ballot process for submitting comments to the U.S. National CAD Standard be explored as a possible template for a more formalized change request system for BIM.

Corporate Configuration for BIM

Ultimately, a corporate (i.e., for the Corps) configuration will need to be developed for BIM. For example, this configuration should include, but not be limited to, the following items:

a. Existing A/E/C CADD Standard resources
b. An established standard folder structure
c. Standard network resource files for software. These resource files will include:
    i. Fonts
    ii. Line styles
    iii. Dimensions styles
    iv. Symbols
    v. Color table
    vi. Plotter configuration drawing (drawing represents the anticipated output from any given plotter full or half size)
    vii. Standard pen table
    viii. Standard plotter calibration file
    ix. Standard plot drivers for CALS, PDF, etc.
    x. Seed files (for coordinate readout, global origin, working units)
    xi. Discipline specific seed files
        1) 2D
        2) 3D
    xii. Sheet specific seed files
    xiii. Model specific seed files
    xiv. Default PCS file
    xv. DGNLIB configuration files

xvi. Add TF annotation resource files*

d. Standard Drawing libraries. Standard drawing libraries will ultimately be developed in this move to BIM. Since the Centers of Standardization are being targeted first for the move to BIM, their standard designs should be collected and posted. Also, any objects developed by the Corps should be stored in a centralized library. ERDC is looking into a means for collecting and posting this information.

Corporate Template Dataset

The corporate template dataset is the common dataset stored across all Corps projects. As part of the start of any project, the corporate template dataset needs to be acquired. This dataset will be the starting point of the design project and data will be added as needed to support the project.

The corporate template dataset will include the most basic data and objects that will typically be encountered in the design of a BIM model. Some of the items that will be included in this corporate template dataset include:

- Parts and families
- Compound parts definitions
- Datagroup definitions
- Standard extraction definitions
- Compound cells
- Components definitions
- Catalogs
- Workspace configuration.

Standard-centric Datasets

At the start of the project, a District or COS standard-centric dataset is added to the corporate template. This dataset includes information that is unique to that building type.

Project Datasets

A project dataset is a combination of the corporate template dataset, the standard-centric dataset and information that has been added by the designers to support the project. It is anticipated that the corporate template dataset will not be all inclusive for every type of project. As a result, project datasets will be developed to contain the data and objects specific to that

* Note: a ProjectWise structure will be provided at a later date. More information on the Corps' ProjectWise is available through the Implementation Fact Sheet available at URL: https://ten.usace.army.mil/Files/9/3/5/CorpswideFactSheet20060630.pdf

project. At the end of every project, a determination will need to be made as to whether data and objects in that project dataset should be submitted for inclusion into the corporate template dataset (U.S. Army Corps Headquarters will develop guidance/policy on how to capture these project datasets for inclusion into the corporate dataset. A potential rewards system for those sites participating in this collection process is being explored.) Similar to the corporate template dataset, the project dataset should also include the following items:

- Parts and Families
- Compound parts definitions
- Datagroup definitions
- Standard Extraction definitions
- Compound cells
- Components definitions
- Catalogs.

Following is the hierarchy for BIM dataset responsibility:

- Headquarters USACE: BIM policy
  - Engineer Research and Development Center: Corporate Template dataset and links to COS/District datasets
    - COS/Districts: Standard-centric datasets and Project datasets

11. Evolution of Data

The project dataset that a District provides to a design team at the beginning of a project, whether it is an in-house project or an A-E project, should become more robust over time. For the default data to grow, there must be a process that supports it. This process must include four steps to update the default data template from design submittals.

1. *Change detection* – Detect changes made to the dataset during the construction of the BIM model.
2. *QC design criteria* – Check that the data meets the requirements of the District's standard facility type.
3. *QC model elements* – Check the submitted elements against the A/E/C CADD and BIM Standards.
4. *Update process* – Update and distribute the enhanced dataset.

See Appendix C "Dataset Evolution Instructions" for more details on the process

12. BIM Design Team Work Instructions

The concept of the default data template is that the Corps of Engineers will provide a folder structure containing "buckets" and the A-E firm will fill the "buckets" up with a BIM and then return the full "buckets" to the Corps of Engineers during submittals. The design teams, especially the A-E teams, must have some formal process to follow, to create the data as it is expected by the Corps of Engineers. The process should be provided at a data orientation meeting for A-E firms that are new to BIM. The BIM Design Team Work Instructions includes instructions on the use of the data and the corresponding module catalog, as well as example submittal requirements.

See Appendix D "BIM Design Team Work Instructions" for additional details.

13. Support from Management

Team Buy-in/Management Expectations

Management needs to realize that there are a lot of issues at stake in the move to BIM. BIM is expected to solve many of the problems associated with the design and construction process currently used by the U.S. Army Corps of Engineers. However, the Corps of Engineers' current design and construction process is unique because of the massive projects that the Corps undertakes. The current process is very cumbersome for typical MILCON projects. To effectively use the BIM process, a District will have to change their current business processes. Ultimately, the BIM process will streamline projects for both Civil Works and MILCON projects.

A fledgling BIM District may find it beneficial to create a District Data and Skill Set Expectation Plan. This should include milestones that support the Building Information Modeling Strategic Plan. But more importantly, it should reflect the needs and the timing of projects within the District. For example, if the District's goals are to get A-E firms on board and working on pending projects, that should be stated so the BIM team can prepare to support that element early in their development, rather than focusing on mentoring other teams within their discipline.

In the move to this new process, management is going to have to realize that productivity will decline at first. This is the case with the use of any new technology, software, or process. However, what has been seen and realized is the amount of data that is carried through all aspects of the life-cycle of a project through the use of BIM. No longer does the data have to

be recreated at each life-cycle phase. True, there will be a loss of time and productivity at first in the move to BIM, but the ultimate results will be both valuable and rewarding to the Corps.

Team Building

A District has a much higher chance for success with BIM if the BIM process is adopted and the team members are unified. There are too many complexities with BIM to allow team members to wander off into the weeds. BIM is a team effort that requires daily contact between its members. Ideally the team will work in close proximity with each other, as Louisville District did with its "BIM Pit." At most sites, this close work proximity will be a completely new concept, but if followed will result in teamwork and camaraderie that has never been experienced at Districts and Divisions.

Weekly modeler meetings (when the members are not in a BIM Pit) are also an excellent way to keep focused on the issues. These meetings can cover modeling, project, or workload issues. Additionally, these meetings are a great place to air frustrations and to get a user-group feel to the team.

14. Technical Support/Mentoring

Technical Support

Technical support can be provided by the vendor providing the BIM software. As mentioned earlier, credits each site has been apportioned through the Bentley ELA may be used to acquire technical support from Bentley in implementing BIM.

Mentoring

The CADD/GIS Technology Center and the U.S. Army Construction Engineering Research Laboratory have been designated as stewards in the Corps movement to BIM.

Louisville District (LRL) has had great success in implementing BIM at their site. As a result of this success, LRL has enough expertise in BIM necessary to assist as a mentor to other Corps sites. The individual discipline leads at LRL have expressed the willingness to help others and the desire to collaborate with peers in their field.

15. Planning Phase

The National Building Information Model Standard (NBIMS) Development Team is planning to adopt the International Alliance for Interopera-

bility's Early Design information exchange format in its first release. When this standard is adopted, planning systems such as Facility Composer, will allow the generation of planning information in the Industry Foundation Class (IFC)/NBIMS format for import into the BIM detailed modeling software.

16. Construction Phase

This section is currently a placeholder until information is collected on this part of the project life-cycle with regard to BIM.

17. O&M Phase

This section is currently a placeholder until information is collected on this part of the project life-cycle with regard to BIM. The National BIM Standard (NBIMS) Development Team is looking at the Construction Operations Building Information Exchange (COBIE) format for its initial release of the NBIMS. When this standard is adopted, Computerized Maintenance Management Systems (CMMS) and Computer-aided Facilities Management Systems (CAFM) will have a standard format for importing BIM information into there software.

18. Contract Language

This section is currently a placeholder until information is collected on these parts of the project life-cycle with regard to BIM:

18.1 Design-Build

- Submittal Reviews
- Data Requirements
- Commissioning Data.

18.2 Design-Bid-Build

- Submittal Reviews
- Data Requirements
- Commissioning Data.

Appendix C: Dataset Evolution Instructions

Contents

1. Purpose

This work instruction will serve as a plan for the enhancement of the default Corps of Engineers dataset and corresponding module catalogue used in creating Corps of Engineers Building Information Modeling (BIM) design projects. It describes how Corps Districts will identify, check and implement changes to the Corps of Engineers dataset and module catalogue based on input from in-house and A-E design submittals as well as enhancements to both Corps of Engineers criteria and BIM software abilities. It also will provide BIM design teams with the direction of the BIM workflow.

2. Applicability

This work instruction applies to all drawing plans, cost estimates, specifications and design analyses generated using Building Information Modeling (BIM) techniques for all design phases, including design review submittals, documents issued to bidders, as-award documents, and as-built documents for Corps of Engineers projects designed in-house and by others.

3. References

Technical Report 01-6, September 2001 A/E/C CADD Standard Release 2.0

4. Related Procedures

These are currently placeholders; each District would have links to their procedural documents.

a. Management of Project Folders
b. Policy for CAD Standardization
c. Construction Procurement Activities
d. As-Built Documents
e. QC/QA Processes for Study/Design Phase.

5. Responsibilities

The BIM Manager is responsible for the maintenance, distribution and use of the Corps of Engineers Template Dataset CD.

6. Procedure

Corps of Engineers Dataset Template

At the beginning of each project, the designer will download and/or receive, via compact disk, the latest version of the Corps of Engineers Dataset for the specific facility type that is intended for the project. The Corps

of Engineers Districts will provide this dataset at request to Corps of Engineers or A/E designers. It will include the following:

- Module Catalogue
- Cell Libraries (2D, 3D, compound, and parametric)
- Data Group System
- Family, Part, and Component Definitions
- Seed Files
- Level Libraries
- BIM Workspace
- Sheet Border
- Text Styles
- Dimension Styles
- Dgn Libraries

This is the template dataset. It is a configured workspace, group of models with templates for output that can be used with confidence that it is in compliance with the A/E/C CADD Standard and National BIM Standard. It has been created by the Corps of Engineers and all data provided has been reviewed by the Corps of Engineers and the District BIM Manager for compliance.

There are instructions for installation of the dataset on the Corps of Engineers BIM Dataset CD.

7. Additions and Changes to the Dataset

The following are avenues of change to the template dataset:

Project Design Changes – The Default Dataset is not intended to be the all inclusive design tool for Districts. Therefore, additions and changes to the delivered dataset are expected during the design of the project.

Criteria Changes – Due to the changing needs of the client, minor changes to the design guide must will take place. These changes must be accounted for in the dataset module catalog and the dataset.

Update to the Software – BIM is a relatively new and evolving process. TriForma is continually updated to account for additional data to be included in the model. It is up to each District to verify that they are working with the appropriate release of the software for their facility type dataset.

BIM Manager Input – The Default Dataset is not considered complete. It is a work in progress and will remain so. As the District BIM Manager detects needs for changes, they will be made.

New Data Requirements - As the development of data transfer to adjacent phases (planning, construction, or O&M) of projects proceed, so will the modeling requirements to support that transfer.

Detection of Change During the Project Design Phase

Each delivered design submittal will be reviewed for quality assurance as explained in the QC/QA Process for Study/Design Phase. In addition, BIM files delivered with each submittal will be evaluated for change from the template dataset delivered at the beginning of the project. Any additions or modifications will be listed and described in written format by the A/E BIM Manager. The District BIM Manager will also do a QA of the BIM files to detect changes to the default dataset. The results of these two sources of change detection will be evaluated by the District BIM Manager to select only relevant and quality data to be used to enhance the default dataset.

8. Quality Control

Quality control of the dataset changes must be accomplished prior to official updates of the facility template dataset. Any changes or enhancements to the software must also be tested to ensure that there is no lost time to designers due to corrupt information or corrupt files. All changes must be evaluated with the following in mind:

- The A/E/C CADD and the National Building Information Model Standards
- Workspace and Software compatibility
- Design Guide compatibility.

9. Editing of the Dataset and Module Catalogue

Once QC is completed, the dataset CD and instructions can be updated. There is an auto opening web page file with the dataset title and directions for use in the root folder of the CD. The web page automatically opens within Window Internet Explorer when the CD is put into a computer CD readable drive. (If this does not properly execute, then double click the autorun.exe file on the root folder of the CD.) There is a link to a “Read Me” file on that web page that contains detail instructions for loading the dataset, dataset version, POC, or other specific information. Each of these files needs to be edited at the time of distribution of each updated dataset. There are three steps:

1. First, edit the "ReadMe.doc" explaining the changes that are included into this version of the dataset that differ from the last dataset. Make sure that all other information is up to date. This should be done with Microsoft Word.
2. Second, edit the Dataset.htm file to include the proper directions for use of this CD. Check that the Readme file is linked properly to this document. It is not difficult to do. All of the information is in text format and can be edited with Microsoft Notepad. Simply make sure that the proper filename is used to match the "Readme File" and make sure that the "Readme File" is in the same folder (the CD root folder) as the Dataset.htm file.
3. Third, copy the other files on the root folder of the CD to the new CD root folder where the first two files reside also. These files should be copied as they are without editing. This includes autorun.inf, shell.exe and any standard images that create the logos on the auto opening page.

10. Distribution of Updated Dataset

There will be no mass mailing of the Corps of Engineers Default Dataset. The dataset will be provided upon request to any new Project Engineer's and/or Project Manager. It is the Project Engineer's and the Project Manager's responsibility to make sure that they are working from the most current version of the dataset. All projects must begin with a newly delivered dataset. It is not permissible to copy in-house datasets to begin new projects. The dataset will only be available from the Center of Standardization in control of that facility type.

11. Data Set Evolution Flowchart

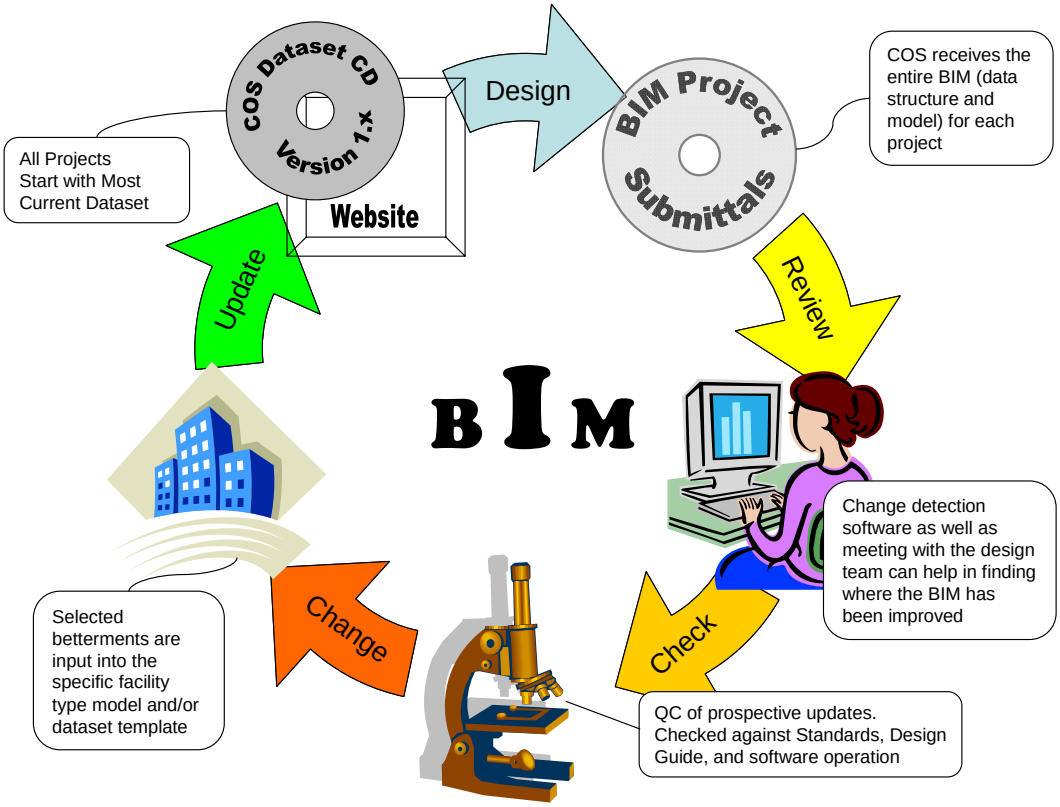

Figure C1. Data set evolution.

Appendix D: BIM Design Team Work Instructions

Contents

1. Purpose

This work instruction will serve as a guide to the in-house and the A-E Building Information Modeling (BIM) design teams in the use of the Corps of Engineers BIM Dataset. The work instruction will guide the enhancement of the Corps of Engineers BIM Dataset and corresponding module catalogue. It will be used during Corps of Engineers Building Information Modeling (BIM) design projects. It describes how Districts will identify, check and implement changes to the Corps of Engineers BIM Dataset and module catalogue based on input from in-house and A-E design submittals, enhancements to Corps of Engineers criteria, and BIM software improvements. It will also provide BIM design teams with direction of the BIM workflow and how to handle changes to this dataset during the design phase and at each submittal.

2. Applicability

This work instruction applies to all drawing plans, cost estimates, specifications and design analyses generated using Building Information Modeling (BIM) techniques for all design phases, including design review submittals, documents issued to bidders, as-award documents, and as-built documents for Corps of Engineers projects designed in-house and by others.

3. References

Technical Report 01-6 Sept 2001 A/E/C CADD Standard Release 2.0

4. Responsibilities

The District BIM Manager is responsible for the maintenance, distribution and use of the Corps of Engineers BIM Dataset CD that includes the USACE Workspace.

The A-E design team is required to deploy the Corps of Engineers BIM Dataset and the USACE Workspace on their server system as to allow their design team the proper tools to create the BIM as it is defined for their specific project. Instructions for server deployment are provided with each release of the Corps of Engineers BIM Dataset.

Design team leaders are responsible for creating project designs within the provided framework and establishing a BIM that contains useful and valuable data for the Corps of Engineers.

5. Procedure

5.1 Corps of Engineers BIM Dataset

At the beginning of each project the designer will download, via the web, and/or receive, via compact disk, the most recent release of the Corps of Engineers BIM Dataset. The Corps of Engineers District will provide this dataset at request to Corps of Engineers or A-E designers. It will include the following:

- Module Catalogue
- Cell Libraries (2D, 3D, compound, and parametric)
- Data Group System
- Family, Part, and Component Definitions
- Seed Files
- Level Libraries
- BIM Workspace
- Sheet Border
- Text Styles
- Dimension Styles
- DGN Libraries
- Color Table
- Font Library

The Corps of Engineers BIM Dataset can be used with confidence that it is in compliance with the A/E/C CADD Standard. Anything found in the delivered dataset that does not comply with the A/E/C CADD Standard should be reported to the BIM Manager. The Corps of Engineers BIM Dataset has been created by the Corps of Engineers and all data provided has been reviewed by the District BIM Manager for compliance with the CADD Standard.

5.2 Modeling Workflow

Figure D1 shows an example workflow used by the Louisville BIM design team while working for the Army Reserves. Using this modeling workflow is not required nor checked, but the U.S. Army Reserve Center BIM Dataset was created with this workflow in mind.

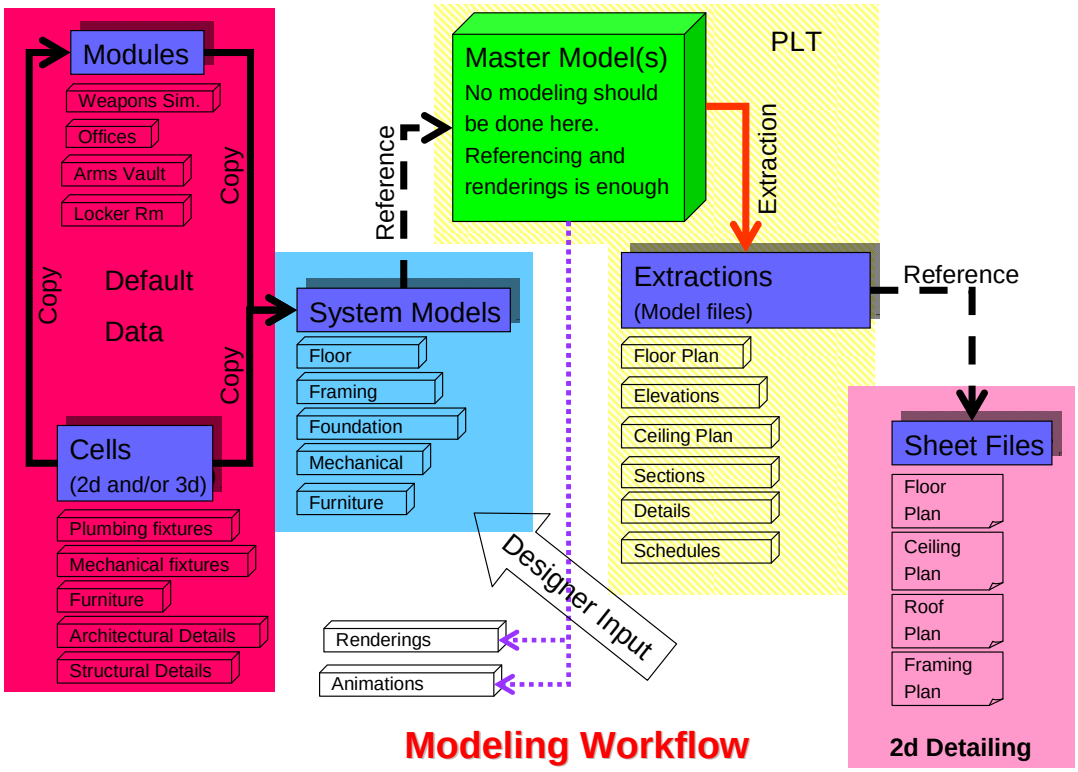

Figure D1. Example workflow used by the Louisville BIM design team.

NOTE: Any design changes to the extraction or sheet file makes the BIM obsolete. It is suggested to make changes to the system models, and then re-run the extractions.

5.2.1 Modules and Cells

The model workflow that was used by Louisville District began with pre-defined data known as cells and modules. This data was provided at the start of a project and contained only data that had been through the quality control process. These were used to give the designer a starting point in the creation of a BIM model. Each module is a space (room) from the Army Reserve design guide. It did not contain all of the data needed to create a BIM, but it was a good start and everything provided was compliant with the A/E/C CADD Standard as well as the Army Reserve design guide.

5.2.2 System Models

The default data is a tool for the designer during the creation of the system models. System models are the heart and sole of the BIM. This is where the design is worked out and all model output comes from this location. This is where the workshop focus is. Digital construction must be embraced here to realize the benefit of significantly reduced change orders during construction.

5.2.3 Master Model

The Project Lead Technician references all system models to create a Master Model. Other less encompassing Master Models can be created for specific reasons such as specific discipline extractions. Extractions are cut here.

5.2.4 Extractions

Each discipline creates their extractions independently due to the complexity of the output data. These extractions must be created within the discipline's modeling tool to make use of rules created for them. Extractions, as well as other types of output, should not be put off until modeling is complete. They are easily updated and can be created at the earliest phases. Louisville District created default extractions and schedules within the USAR/USACE BIM Workspace.

5.2.5 Sheet Files

The extractions are referenced to the standard sheet file complying with A/E/C CADD Standard. The USAR/USACE BIM Workspace developed between Louisville District and Bentley moved the tedious task of selecting levels, line weights, sheet borders, text styles, dimensioning styles, line styles and more into the background, similar to the way DOS runs behind Windows.

5.2.6 Quality Check (not shown above)

The BIM Manager must check all of the files against drawing library files using the standards checker utility within Bentley tools. This ensures that the proper family, parts, dimension style, line styles, text styles, levels and other standards were used and that the output complies with A/E/C CADD Standard. To take advantage of this tool, a strong dataset and workspace must be established. Model interferences must also be checked. Each discipline and the Project Lead Technician should run the Interference Man-

ager to identify design or model conflicts. Louisville District accomplished this using Bentley Navigator together with Interference Manager.

5.3 Types of Changes to the Dataset

The following are avenues of change to the default dataset considered in this work instruction:

- *Design Changes* – The Default Dataset is not intended to be the all inclusive design tool for the Corps of Engineers. Therefore, additions and changes to the delivered dataset are expected.
- *Criteria Changes* – Due to the changing needs of the client, minor changes to the design guide must take place from time to time. These changes must be accounted for in the dataset module catalogue and the dataset.
- *Update to the Software* - BIM is a relatively new and evolving process. The Bentley Building tools are continually updated to account for additional data and disciplines being included in the model.
- *BIM Manager Input* – The Default Dataset is not considered complete. It is a work in progress and will remain so. As the District BIM Manager detects needs for changes, they will be made.
- *BIM Standards* – The A/E/C CADD Standard was developed from a 2D perspective. It uses levels to differentiate vector elements. They are sometimes used to represent a 3rd dimension that is not modeled (e.g., topographic elevation or ceiling grid). There are obvious differences in the use of levels when creating a BIM, therefore the need of additional levels is inevitable. Levels are the biggest area of change to the A/E/C CADD Standard, but not all. Ultimately, the CADD/GIS Technology Center will release a BIM Standard that includes both the A/E/C CADD Standard and BIM-specific levels and symbology.

5.4 QA/QC and Detection of Changes to the Dataset

Proposed changes to the BIM dataset must be received, evaluated, and judged without slowing the design process. Therefore we have developed a submittal process for changes to the A/E/C CADD Standard and BIM standards during the design phase. For change submittals, visit URL:

https://tsc.wes.army.mil/comments/AECSDS_comments/AECSDS-CommentForm.asp

Once there, follow all instructions and submittal requirements. The design team should make the needed change, submit the change, and go on with

the design as if it had been accepted. However, the design team must be willing to reverse or alter their model if their submitted change is not accepted into the standard.

Designers, both A-E and in-house, will perform Quality Control (QC) checks of the dataset just prior to each submittal. Documentation created during those checks shall be submitted at the time of the project submittal BIM Data Report. Any elements within the model not meeting the requirements shall have an explanation of the reason that they were left as they were. These issues should be brought to the attention of the BIM Manager for consideration of standards updating at the dataset review meeting. There are four types of checks that must be made on the model:

- *Visual Check* – This can be accomplished by checking the small segments of the model at a time using cameras within MicroStation or the entire model using Bentley Navigator. The main reason for this check is to ensure the design intent has been followed and that there are no unintended elements in the model.
- *Interference Check* – This check is performed using Bentley Navigator together with Bentley's Interference Manager. It is used to locate problems in the model where two objects are occupying the same physical space.
- *Standards Check* – This is performed using the "standards checker" tool within the Bentley software. This is used to ensure that the fonts, dimensions, line styles, levels and other issues are followed per the BIM and A/E/C CADD Standard.
- *TriForma Element Validation* – The validation tool on the datagroup dialogue will run this tool and it is used to ensure that the dataset has no undefined or incorrectly defined elements.

At the time of delivery of each design submittal, the design team will make arrangements for a dataset review meeting with the BIM Manager. This meeting is intended to communicate changes and additions to the Corps of Engineers BIM Dataset. This will enable the BIM Manager to determine what elements should be considered for inclusion to the Corps of Engineers BIM Dataset future releases. This meeting will also give the A-E an opportunity to suggest changes to the process, workspace, standards, or dataset. This meeting will be coordinated through the Project Manager.

Each delivered design submittal will be reviewed for quality assurance (QA) as explained in the QC/QA Processes for Study/Design Phase. In addition, BIM files delivered with each submittal will be evaluated for differences from the default dataset folders and files to determine if the proper files within the dataset have been edited. The BIM Manager will also do QA of the submitted BIM files to ensure that the QC was properly performed.

The results of these sources of change will be evaluated by the BIM Manager who will select only relevant and quality data to be used for enhancement of the Corps of Engineers BIM Dataset.

6. Example BIM Submittal Requirements

All submitted BIM models, extraction files, extraction definitions, sheet files, renderings, Navigator files, and output files must have been created in Bentley's Building suite of tools and in the version of those tools in which the Corps of Engineers Dataset CD was provided. This dataset is dependent on the specific versions of the Bentley suite of building tools. Only the versions of software that are listed in the A-E instructions, included on the Corps of Engineers Default Dataset CD, are permitted to be used.

Since the concept of BIM is to digitally build the structure, it is inherent that all design work be preformed from the perspective that all elements and relationships between them are modeled as they would be built. The designer shall use sound engineering, architectural, and construction judgment when placing elements on specific parts within families within BIM. The family and part configuration provided within the dataset does not intend to account for all types of construction elements; rather the intent is to establish a solid starting base to be built upon. The designer of record must understand the use of parts within the BIM model for them to expand this list for their specific project needs. Family and parts must be used to differentiate groups of elements with the BIM model to create the following:

- Quantity takeoffs for calculation of cost of all construction materials and activities related to the installation of those materials.
- Extraction of visual data to files for the creation of contract drawings on sheet borders.

- Renderings of the BIM model for communication of design and as a deliverable to the client.
- Support of the construction model data extraction
- Querying of elements so to make changes to the design as needed.
- Re-symbolization of elements through the extraction process
- Level management
- Design schedules

6.1 Interim Submittal (General)

This BIM submittal should include all of the major components of civil, architecture, interior design, structural, mechanical, electrical, fire protection, and information systems as well as complete building elevations. All drawings supporting this submittal should come directly from the model using the extraction processes. There are exceptions to this for design elements that are not supported by the Bentley BIM software. At this point of the BIM process, only civil, electrical, and fire protection elements are permitted to be created and stored outside of the BIM. The following paragraphs describe most conditions for when an element should and should not be in the model. It is left to the designer's judgment as to what value a specific element gives to the model and therefore what should be included in the BIM model beyond minimum requirements.

6.2 Architectural Model Minimum Requirements and Output

The Architectural systems models may vary in level of detail for individual elements within a model, but at a minimum must include all features that would be included on a ¼-in to 1-ft, 0-in. scaled drawing. Additional minimum requirements are:

- **Walls** -The architectural model(s) should include all walls, both interior and exterior. They should be modeled as they would be built; meaning with enough detail to get quality quantity takeoffs on all construction materials used. They should also be accurate enough that all floor plan and elevation extractions are accurate to the design intent. Exterior banding or brickwork, entrance features, and special interior features should be modeled at this stage for communication to the client at review. Each wall shall be to the exact height, length and width so to properly account for space allocation. Fire ratings of walls shall be indicated by using the proper

family and part for those wall types. Extractions should re-symbolize properly to identify them.

- **Doors and Windows** – Doors and windows should be modeled to represent the actual size and location on all exterior elevations. They should be the exact door or window that is intended by the Architect in all respects, including size and style. Doors and windows shall be placed using the Bentley door or window tool and they shall be of a cell type that supports the door and window templates provided by the USACE BIM Dataset CD as well as the datagroup system for labeling and other BIM functions. They cannot be placed as independent cells. They must be placed within these tools so that the datagroup system can accurately count and hold data for the doors and windows.
- **Roof** – The roof system must be modeled within the BIM model. The level of detail for the roof system must be adequate to communicate the roof configuration and the method by which the water is removed from structure. Again, this must be modeled as it is built. This does not mean that the entire roof structure must be modeled at this submittal, but it does mean that an adequate place holder representing size, shape and configuration must be modeled. Most quantities can be derived from the surface area and the depth of the roof assembly.
- **Floors** – The floor slab shall be modeled in either the Architectural model or the structural model and then referenced by the architectural models for each floor slab.
- **Ceilings** – All ceilings shall be modeled using either Bentley's ceiling tool or form modeling to create special ceiling features. All ceilings, including soffits or other special conditions shall be in the model at this submittal.
- **Spaces** – The spaces are a very important element in this submittal. They should be modeled to complete accuracy as to obtain accurate net square footage requirements and to hold data for the room and finish schedules that draw information from them. Room names and numbers should also be finalized within the model for output to schedules for all disciplines.
- **Furniture** – A furniture cell library has been provided in the Corps of Engineers BIM Dataset.

- **Schedules** – Provide door and room finish schedules from the BIM model indicating the materials and finishes used in the design. Also a special item schedule and/or notes shall be provided indicating any special items that will be required for the design. The room finish schedule template is provided within the dataset. Due to the specific nature of the special items schedule, it shall not be required as an output of the BIM, but there are additional templates in development, and these will be required on future projects to support specific output tasks of the design team. These schedules are created with the datagroup system and any additional schedules created during the design process shall be placed in the same location.
- **Extractions** – The extraction process should be well established at the interim submittal. All but a very few extraction definitions should be complete and submitted within the master models. It is suggested that the design team begin with the extraction definitions provided with the dataset and build from there.
- **Datagroup** – The Datagroup information should be complete at the interim submittal and should not be edited beyond this stage unless large building usage changes have been made. All Excel spreadsheet output should be configured and waiting for any additions or changes made later in the design process.
- **Dataset** – All dataset issues should be resolved at the interim submittal. Any additional families, parts, line styles, special dimension styles, or level not provided in the Corps of Engineers BIM Dataset CD shall be submitted to the BIM Manager at this and every submittal. (See section "QA/QC and Detection of Changes to the Dataset" for guidance on standard and dataset change requests)
- **Quality Verification** - All quality checks listed in the section "QA/QC and Detection of Changes to the Dataset" shall be completed for all files and disciplines. Output of those checks shall be submitted with the normal submitted materials. In addition, documentation of all unresolved interferences, standards, TriForma elements along with an explanation, shall be submitted. A quality check for compliance with the A/E/C CADD Standard must also be completed on the final file condition prior to submittal and the results of that standard check must be included in the submittal.
- **Design Analysis** - The model must support the design analysis whenever possible and prudent. That decision must be made by

comparing the value of the output from the model versus the work added to computer processing, which is affected by the level of detail.

- **Drawings** – All drawings that contain information that resides in the model shall be generated from the BIM model in the extraction process. Standard details, index sheet, and other typical drawings need not be included in the BIM model. Civil and electrical drawings are also exempt from the BIM process due to the lack of software applications supporting these disciplines at this time. Submittals must include the extraction files, sheet files, special patterning, line styles, cells, referenced files or other specific files used to create the drawings as output of the model. All files must be in the proper location within the USACE Workspace delivered on the Corps of Engineers BIM Dataset CD. The District must be able to recreate the BIM process to review the drawings and model. Simple images are not acceptable and are not direct outputs of the BIM.

6.3 Specific Drawings requirements:

- **Composite Floor Plan** - If the main floor plans must be shown in segments to comply with the requirements of the proper scale, provide a smaller scale floor plan from the BIM model showing exterior walls, interior partitions, circulation elements and cross referencing for enlarged floor plans and sections. Show overall dimensions on the floor plan and gross building areas tabulation on the drawing. Tabulated data such as gross square footage shall be considered an output of the model.
- **Floor Plans** - Provide floor plans from the BIM at 1:100 or 1:50 scale. Show gross floor area tabulations if no composite sheet is included. Tabulated data such as gross square footage shall be considered an output of the model.
- **Building Elevations** - Provide building elevations from the BIM model showing grading, openings, principal exterior materials and general profiles of the building (scale shall be the same as the floor plans).
- **Roof Plan** - Provide a roof plan from the BIM model showing the roof configuration and methods by which rain is directed to the building perimeter.

- **Building and Wall Sections** - Provide typical wall sections (1:20 minimum scale) that indicate major elements. Wall sections shall be unbroken where practical and indicate materials and floor-to-floor heights. Building sections shall be an output of the model, but wall sections and details are typical and at such a large scale that they shall not be required as an output of the BIM model.
- **Reflected Ceiling Plan** - Provide a ceiling plan from the BIM model that indicates ceiling material and open ceiling areas. Indicate room numbers, light locations, registers, and all ceiling mounted items, such as exit signs.
- **Fire Protection/Life Safety Plan** - Provide fire protection/life safety drawings from the BIM model that indicate fire suppression information, exit signs, pull stations, exit devices, exit distances, emergency lights, detectors, alarm locations and fire panel locations. Summarize the code information from the design analysis on the drawings.

Appendix E: A/E Contract Language

This Appendix will contain guidance on A/E contract language related to BIM.

Appendix F: District Oversight and A-E BIM Implementation Guidance

This Appendix will contain further guidance to districts on how to manage projects and A-Es that will be implementing BIM using Corps datasets and procedures.

Appendix G: Example – Army Position Description for BIM Manager

Army Position Description

DA PD#:
Installation: U.S. Army Corps of Engineers, Louisville District
Title: CIVIL ENGINEERING TECHNICIAN

Citations:
1)OPM PCS ENGR TECH SERIES, GS-802, AUG 74
Series: 0802
Pay Plan: GS
Grade: 12
Fair Labor Standards Act:
MACOM: COE
Region: South Central

Duties:
SUPERVISORY CONTROLS
Works under general supervision of the Section Chief. Supervisor makes initial overall project assignments in terms of broad general objectives, anticipated problem areas, and relative priorities. Exercises considerable freedom in selecting and establishing proper procedures and methods to be employed in solving complex engineering and project management problems and for otherwise carrying projects through to completion. Controversial matters involving policy considerations, together with recommended solutions, are referred to and discussed with supervisor for joint agreement on conclusions. Completed work is reviewed for adequacy in terms of the broad objectives of the work and for compliance with policies and regulations.

MAJOR DUTIES
Summary: Incumbent is responsible for carrying out, directing, and coordinating all work associated with Building Information Models (BIM), including project planning, design, engineering management, construction, operation and overall coordination, and for providing authoritative advice,

assistance and information on all matters related to BIM. Leads and directs other technicians, engineers, architects, and other technical specialists. Projects may involve all of the following type projects: military facilities, including Army Reserve and Air Force Reserve projects nationwide; civil works projects such as navigation, flood protection, and dam safety; environmental restoration; and support/work for others projects for non-traditional customers. Work typically requires intensive coordination of project work requirements with other technical and administrative elements of the District to ensure technical adequacy, completeness, timeliness, and consistency of the finished product. Work requires the application of a comprehensive and specialized knowledge of engineering principles, methods and techniques, and criteria relating to digital project design. Incumbent serves as coordinator for project teams working in the BIM environment. This position includes a wide scope of assignments, work objectives, and responsibilities similar in nature to those characteristically assigned to professional engineering positions. However, management has determined that the assignments of this position can be effectively accomplished by a person applying extensive practical experience, and management has determined that the position will function under the technician rather than the professional engineering concept. Guidelines include Federal laws, congressional acts, published reports, higher authority directives, engineering texts and manuals, technical periodicals, and CELRD and HQUSACE policies and other comparable publications pertaining to project design, construction, and support of facility operation and maintenance. Such guidelines are broad and general and require the use of Judgment in selecting alternative approaches, and if required, developing new methods and procedures. In this capacity, performs or coordinates the performance of the following:

1. Database Management.

Based on experience, a thorough knowledge of engineering and general design requirements, and input from other affected elements, develops and maintains a standard data set template, a data set template specific to the standard facilities Louisville District is responsible for as a Center of Standardization, and a Module Catalog/Cell Library. Prepares and updates these technical products for use by in-house and AE firms' design teams, construction contractors, and facility operation and maintenance staff's management of projects from inception through operational project life.

Reviews cells and modules generated in the process of designing projects in BIM and incorporates the best elements into the standard templates and libraries. Reviews all information to assure compliance with established criteria, published regulations, and overall project requirements. Is directly responsible to resolve and finalize problems, issues, and questions associated with the databases by coordinating with project delivery teams, hardware/software vendors, other technical resources, and customers for the appropriate resolution. Determines requirements for input from other organizational elements, and maintains liaison with all affected organizations to inform them of any changes in the standard templates/libraries. Interfaces with AE firms that are contracted to design projects in BIM, construction companies that use the BIM model to produce as-built documents, and facility managers who use the resultant model for operation and maintenance; provides access to appropriate datasets, libraries, standards, etc. Answers questions and provides guidance as needed to support these BIM users. Reviews and comments on AE and construction submittals for compliance with BIM-related aspects of their contracts. Incorporates appropriate elements of AE/contractor produced models into the standard databases/libraries.

25%

2. Project Execution

Coordinates the software/hardware aspects of all projects produced by in–house design teams in the BIM environment. Advises management on design team composition. Coordinates with design team members, software vendor(s), customer, etc. to arrange all aspects of the initial project workshop. Establishes the digital workspace and initial project dataset based upon the project's and customer's requirements. Participates as needed in project workshops, to include providing training/mentoring of PDT members. Provides on-going troubleshooting support to design teams. Monitors and coordinates the preparation of models and supports the PDT in assembling all required information necessary to produce the finished product. Monitors preparation of all products produced in the BIM environment. Monitors and coordinates the preparation of all required project-specific information and supports the assembly of all information necessary to produce the finished product. Reviews all information to assure compliance with established criteria, published regulations, and over-

all project requirements. Identifies areas of conflict and refers unresolved problems to supervisor with recommendations for problem resolution. Is relied upon to recognize matters of sufficient importance to warrant the attention of immediate supervisor.

30%

3. Training

Provides and coordinates training to maximize the benefits of BIM technology. Coordinates initial annual update training, as needed, as well as project-specific training workshops. Personally participates in update and project workshop training when needed. Provides on-going training to individual BIM users throughout the course of project design when requested. Interfaces with AE firms, construction contractors, and facility managers to develop and enhance their use of the BIM technology. Provides management briefings regarding technology advancements and associated recommendations, program plans, and status. Advises management regarding staff training needs/opportunities. Makes presentations at conferences and to professional organizations as requested and approved.

20%

4. Program Management

Manages the technical/functional aspects of the BIM Program for Louisville District to maximize benefits to district customers. Interfaces with HQUSACE, ERDC, software vendors, other district/divisions, AE firms, and other engineering organizations to advance and/or stay current with the state of the art for engineering design/construction/management technology, including both software and hardware, related to BIM. Develops and recommends approval of district policy regarding BIM. Briefs management and customer representatives on the status of the program, milestone achievements, and technological advancements being applied. Establishes standards for use of BIM at/for Louisville District in coordination with design teams, district management, ERDC, HQUSACE, customer organizations, and other relevant contacts. Manages BIM software for the district, exercises version control, and researches and makes recommendations to management regarding expenditures for upgrades. Participates

actively in Corps-wide planning, development and production programs related to BIM.

25%

Performs other duties as assigned.

Appendix H: Memorandum, Subject – Realignment/Establishment of Centers of Standardization (COS), FY06

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

MAR 0 8 2006

CECW-CE (1110)

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Realignment/Establishment of Centers of Standardization (COS), FY-06

1. Army Transformation and MILCON Transformation will have a profound impact on the way USACE COS and military districts will execute MILCON in FY-06 and beyond. MILCON Transformation will rely increasingly on design-build acquisition and will result in larger projects in some areas of the country and less in-house design. COS will be involved increasingly in the planning, programming and execution of their designated facility types.

2. To meet these challenges HQUSACE has elected to redistribute the COS. The enclosures show the facility assignments and define expanded duties of the COS. Although specific Corps Districts are identified, MSC can and should consider use of regional resources to support COS duties and responsibilities as deemed most effective and efficient.

3. Each MSC will acknowledge and accept their revised COS assignments by providing a Project Management Plan (PMP) to the Points of Contact thirty days from the date on this memorandum. PMP will address how the COS proposes to meet the duties listed on the enclosure with respect to their assigned facility types. Include in-house and contract support, staffing requirements and proposed costs.

4. FY-06 will be a transition year for the assignments. Full capability in reassignments will be effective with the MILCON Transformation instructions issued for FY-07.

5. HQUSACE (CECW-CE-D) will host a COS workshop within fifteen (15) days of receipt of MSC COS PMP for discussion of duties, responsibilities and expectations. Points of Contact for this action are Albert Young, telephone (202) 761-7419 or Frank A. Norcross, AIA, IIDA, telephone (202) 761-7500.

Encls

This way ahead will make us more effective providers of technical services while helping us sustain our core technical competencies through our RBCs and COSs.

MERDITH W.B. TEMPLE
Brigadier General, USA
Director of Military Programs

CECW-CE
SUBJECT: Realignment/Establishment of Centers of Standardization (COS), FY-06

DISTRIBUTION:
ASSISTANT CHIEF OF STAFF FOR INSTALLATION MANAGEMENT (DAIM-FD)
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US ARMY ENGINEER DIVISION, MISSISSIPPI VALLEY
US ARMY ENGINEER DIVISION, NORTH ATLANTIC
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US ARMY ENGINEER DISTRICT, FORT WORTH
US ARMY ENGINEER DISTRICT, HONOLULU
US ARMY ENGINEER DISTRICT, LITTLE ROCK
US ARMY ENGINEER DISTRICT, LOUISVILLE
US ARMY ENGINEER DISTRICT, MOBILE
US ARMY ENGINEER DISTRICT, NORFOLK
US ARMY ENGINEER DISTRICT, OMAHA
US ARMY ENGINEER DISTRICT, SACRAMENTO
US ARMY ENGINEER DISTRICT, SAVANNAH
US ARMY ENGINEER DISTRICT, TULSA
US ARMY TRANSATLANTIC PROGRAMS CENTER
US ARMY ENGINEER DISTRICT, AFGHANISTAN
US ARMY ENGINEER DISTRICT, ALASKA
US ARMY ENGINEER DISTRICT, ALBUQUERQUE
US ARMY ENGINEER DISTRICT, BALTIMORE
US ARMY ENGINEER DISTRICT, BUFFALO
US ARMY ENGINEER DISTRICT, CHICAGO
US ARMY ENGINEER DISTRICT, CHARLESTON
US ARMY ENGINEER DISTRICT, DETROIT
US ARMY ENGINEER DISTRICT, FAR EAST
US ARMY ENGINEER DISTRICT, GALVESTON
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CECW-CE
SUBJECT: Realignment/Establishment of Centers of Standardization (COS), FY-06

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US ARMY ENGINEER RESEARCH AND DEVELOPMENT CENTER (CEERD-ZA, CEERD-CZ-V, CEERD-RV, CEERD-IV, AND CEERD-TV)
DEPUTY COMMANDERS, HQUSACE/OCE
CHIEFS OF SEPARATE OFFICES, HQUSACE/OCE
REGIONAL INTEGRATION TEAMS, HQ

Realignment of Centers of Standardization (COS)
Department of the Army Facilities Standardization Program

Engineering and Support Center
1. Huntsville (CEHNC)
   Standard Facility Types (Total = 15)
   Physical Fitness Facility
   Outdoor Sports Facility
   Child Development Center - Infant/Toddlers
   Child Development Center - School-Age
   Youth Activity Center
   Consolidated Fire, Safety & Security Facility
   Fire Station
   Army Community Service Center
   Bowling Center RFP
   Hazardous Material Storage Facility
   Close Combat Tactical Trainer
   Military Operations Urban Terrain Facility (DAMO-TR funded/programmed)
   Training Ranges (DAMO-TRS funded/programmed)
   Proposed New Battle Command Training Center (Requested by DAMO-TRS, G3/5/7)
   Proposed New Training Support Center (Requested by DAMO-TRS, G3/5/7)

Great Lakes and Rivers Division
2. Louisville District (CELRL)
   Standard Facility Types (Total = 2)
   Army Reserve Center
   Operational Readiness Training Complex (ORTC)

North Atlantic Division
3. Norfolk District (CENAO)
   Standard Facility Types (Total = 7)
   General Instruction Building (GIB)
   Classroom 21
   Enlisted Personnel Dining Facility
   Military Entrance Processing Station (MEPS)
   Family Housing RFP
   Information Systems Facility
   Criminal Investigation Facility

Northwestern Division
4. Omaha District (CENWO)
   Standard Facility Types (Total = 2)
   Religious Facility
   Access Control Points

Realignment of Centers of Standardization (COS)
Department of the Army Facilities Standardization Program

South Atlantic Division
5. Mobile District (CESAM)
Standard Facility Types (Total = 3)
Aviation -Vertical Construction
4-Star HQ Facility – see footnote
National Guard Armory

6. Savannah District (CESAS)
Standard facility Types (Total = 6)
Company Operations Facility
Tactical Equipment Maintenance Facility
Brigade Operations Complex
Brigade/Battalion HQ: Admin
Command and Control Army (UEy) & Corps (UEx) HQ: Admin/Opns
Deployment Facility

Southwestern Division
7. FT Worth District (CESWF)
Standard Facility Types (Total = 5)
Unaccompanied Enlisted Personnel Housing (Barracks)
Basic Combat Training Complex (BCT) / One Station Unit Trainee (OSUT)
Advanced Individual Training Complex (AIT)
General Purpose Warehouse
Central Issue Warehouse

Pacific Ocean Division
8. Honolulu District (CEPOH)
Standard Facility Types (Total = 2)
Unaccompanied Officers Quarters.
Transient Officers Quarters.

Footnote: Three MACOM HQ standards to be developed by CESAM

Encl

DUTIES OF CENTERS OF STANDARDIZATION (COS)

COS will perform the following functions in support of the HQUSACE proponent, DAIM, IMA, and the Facilities Design Team (FDT) for their assigned facility types.

1. Develop the standard design, standard criteria and UFCs in consultation with DAIM, IMA, HQDA facility proponent, MACOM, and contract/district resources. For each facility type:

a. Develop and maintain Building Information Models (BIM).

b. Maintain Model Request for Proposals (RFP) Statements of Work (SOW)

c. Provide consultation services to districts involved in the design and construction of assigned facilities.

d. Maintain historical database of standard design use by FY, PN and location.

2. Participate as an integral member of the MILCON Transformation Team.

3. Participate in planning charettes (DD Form 1391 development) for designated facility types to ensure consistent application of criteria, and to validate scope.

4. Participate in design charettes or RFP development to ensure that the standard design intent is maintained through design development.

5. Review Code 2/3 design documents for compliance with standard design requirements.

6. Populate the Corporate Lessons Learned (CLL) web site lessons observed/learned system to provide meaningful, detailed information to DAIM, IMA, and USACE in a user-friendly format on demand.

7. Attend selected post-occupancy evaluations with the design district, IMA, ACSIM, and HQDA proponent to obtain user feedback and lessons learned.

8: Establish regional Indefinite Delivery Indefinite Quantity (IDIQ) Contracts for services associated with assigned facility types.

9. Explore, adopt, and implement new technologies (processes, materials, equipment, and methods) that support standards and improve facility management.

Appendix I: BIM Related Roles and Responsibilities

Point of Contact	Organization	Role	Responsibility	Phone	email
USACE Headquarters					
M.K. Miles	USACE HQ	Strategic Guidance	BIM, CAD, ProjectWise	202-761-5532	Moody.K.Miles@hq02.usace.army.mil
Bob Bank	USACE HQ	Strategic Guidance	BIM, CAD, ProjectWise	202-761-4243	Robert.Bank@hq02.usace.army.mil
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International Organization for Standards (ISO)		Standards and Implementation			
National Geospatial-Intelligence Agency (NGA)		Standards and Implementation	DFDD and Feature catalog		
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Bentley		Applications	BIM software - TriForma	1-800-BENTLEY	
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14. ABSTRACT

Building Information Modeling (BIM) is a technology that is rapidly gaining acceptance throughout the planning, architecture, engineering, construction, operations, and maintenance industries. The challenge to the U.S. Army Corps of Engineers (USACE) is to proactively prepare for BIM, use it to drive down costs and delivery time, and maintain or even improve quality at the same time. This document outlines the strategic and implementation plans for using BIM technology to improve USACE planning, design, and construction processes. It describes how USACE will meet or exceed the vision of its customers, including the Office of the Secretary of Defense (OSD), the Army, and the Air Force. The scope of this plan is to focus on the implementation of BIM in the U.S. Army Corps of Engineer's civil works and military construction business processes, including the process for working with the USACE Architectural Engineering Construction (AEC) industry partners and software vendors.

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